

NASA SP-7037 (329)
April 1996

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Introduction

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The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the publication consists of a standard bibliographic citation accompanied, in most cases, by an abstract.

Two indexes—subject and author are included.

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Typical Report Citation and Abstract

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↓

ACCESSION NUMBER → **N96-10751#** Sandia National Labs., Albuquerque, NM. ← **CORPORATE SOURCE**

TITLE → **Minimizing phylogenetic number to find good evolutionary trees**

AUTHORS → Goldberg, Leslie Ann; Goldberg, Paul W.; Phillips, Cynthia A.; Sweedyk, Elizabeth (California Univ., Berkeley, CA.); and Warnow, Tandy (Pennsylvania Univ., Philadelphia, PA.) ← **AUTHORS' AFFILIATION**

PUBLICATION DATE → 1995 26 p Presented at the 1995 Symposium on Combinatorial Pattern Matching, Helsinki, Finland, 4-7 Jul. 1995 Sponsored by California Legislative Grant

CONTRACTS/GRANTS → Contract(s)/Grant(s): (DE-AC04-94AL-85000; NSF CCR-94-57800)

REPORT NO.(S) → Report No.(s): (DE95-011893; SAND-95-0831C; CONF-9507123-1) Avail: CASI HC A03/MF A01 ← **AVAILABILITY AND PRICE CODE**

ABSTRACT → Inferring phylogenetic trees is a fundamental problem in computational-biology. We present a new objective criterion, the phylogenetic number, for evaluating evolutionary trees for species defined by biomolecular sequences or other qualitative characters. The phylogenetic number of a tree T is the maximum number of times that any given character state arises in T. By contrast, the classical parsimony criterion measures the total number of times that different character states arise in T. We consider the following related problems: finding the tree with minimum phylogenetic number, and computing the phylogenetic number of a given topology in which only the leaves are labeled by species. When the number of states is bounded (as is the case for biomolecular sequence characters), we can solve the second problem in polynomial time. We can also compute a fixed-topology 2-phylogeny (when one exists) for an arbitrary number of states. This algorithm can be used to further distinguish trees that are equal under parsimony. We also consider a number of other related problems. DOE

SUBJECT TERMS → *Algorithms; Biological Evolution; Chemical Evolution; Genetics; Molecular Biology*

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 329)

APRIL 1996

01 AERONAUTICS (GENERAL)

N96-16748# General Accounting Office, Washington, DC. National Security and International Affairs Div.

US Special Operations Forces: Helicopter cost is understated and reliability measures are inadequate. Report to Congressional requesters

25 Jan. 1994 20 p

Report No.(s): (GAO/NSIAD-94-46; B-240262) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

This report discusses issues related to cost and planned reliability measures associated with MH-47E and MH-60K Special Operations helicopter program. Our objectives were to determine whether (1) the United States Special Operations Command (USSOCOM) has provided Congress with appropriate cost information for the MH-47E and MH-60K helicopter program and (2) the Army's reliability measures for the MH-47E and MH-60K helicopters are adequate. Substantial costs are not required to be included in the MH-47E and MH-60K budget documents under current DoD budget policy. At least \$367 million in procurement costs have not been included in the \$1.2 billion in development and procurement estimates because these costs are included in budget documents for Army programs or activities. Also, the total cost to support and maintain the aircraft, estimated to be at least \$3.6 billion, has not been reported to Congress. The primary reliability measurement criteria the Army will use to assess the helicopters' reliability is flawed because it only measures their ability to return to friendly territory and not their ability to perform special operations missions.

Derived from text

Aircraft Production Costs; Aircraft Reliability; Ch-47 Helicopter; Congressional Reports; Cost Estimates; H-60 Helicopter; Operating Costs;

02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

N96-16260*# Old Dominion Univ., Norfolk, VA. Dept. of Aerospace Engineering.

Domain decomposition for aerodynamic and aeroacoustic analyses, and optimization Final Report, period ended 30 Sep. 1995

Baysal, Oktay; 1 Dec. 1995 9 p

Contract(s)/Grant(s): (NAG1-1499)

Report No.(s): (NASA-CR-199786; NAS 1.26:199786; NIPS-95-06479) Avail: CASI HC A02/MF A01

The overarching theme was the domain decomposition, which intended to improve the numerical solution technique for the partial differential equations at hand; in the present study, those that governed either the fluid flow, or the aeroacoustic wave propagation, or the sensitivity analysis for a gradient-based optimization. The role of the domain decomposition extended beyond the original impetus of discretizing geometrical complex regions or writing modular software for distributed-hardware computers. It induced function-space decompositions and operator decompositions that offered the valuable property of near independence of operator evaluation tasks. The objectives have gravitated about the extensions and implementations of either the previously developed or concurrently being developed methodologies: (1) aerodynamic sensitivity analysis with domain decomposition (SADD); (2) computational aeroacoustics of cavities; and (3) dynamic, multibody computational fluid dynamics using unstructured meshes.

Derived from text

Aeroacoustics; Aerodynamic Characteristics; Airfoils; Cavity Flow; Computational Fluid Dynamics; Partial Differential Equations; Unstructured Grids (mathematics);

N96-16433*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA. **Ground-recorded sonic boom signatures of F-18 aircraft formation flight**

Bahm, Catherine M.; and Haering, Jr., Edward A.; Sep. 1995 27 p Presented at the NASA High Speed Research Program Sonic Boom Workshop, Hampton, VA, 11-13 Sep. 1995

Contract(s)/Grant(s): (RTOP 537-03-21)

Report No.(s): (NASA-TM-104312; H-2067; NAS 1.15:

104312) Avail: CASI HC A03/MF A01

Two F-18 aircraft were flown, one above the other, in two formations, in order for the shock systems of the two aircraft to merge and propagate to the ground. The first formation had the canopy of the lower F-18 in the inlet shock of the upper F-18 (called inlet-canopy). The flight conditions were Mach 1.22 and an altitude of 23,500 ft. An array of five sonic boom recorders was used on the ground to record the sonic boom signatures. This paper describes the flight test technique and the ground level sonic boom signatures. The tail-canopy formation resulted in two, separated, N-wave signatures. Such signatures probably resulted from aircraft positioning error. The inlet-canopy formation yielded a single modified signature; two recorders measured an approximate flattop signature. Loudness calculations indicated that the single inlet-canopy signatures were quieter than the two, separated tail-canopy signatures. Significant loudness occurs after a sonic boom signature. Such loudness probably comes from the aircraft engines.

Author

Aircraft Engines; Engine Noise; F-18 Aircraft; Flight Conditions; Loudness; Noise Measurement; Signatures; Sonic Booms;

N96-16635*# California Univ., Los Angeles, CA.

A computational fluid dynamics simulation of the hypersonic flight of the Pegasus(TM) vehicle using an artificial viscosity model and a nonlinear filtering method M.S. Thesis

Mendoza, John Cadiz; Washington NASA Sep. 1995 118p Contract(s)/Grant(s): (RTOP 466-01-00)

Report No.(s): (NASA-CR-186033; H-2071; NAS 1.26:186033) Avail: CASI HC A06/MF A02

The computational fluid dynamics code, PARC3D, is tested to see if its use of non-physical artificial dissipation affects the accuracy of its results. This is accomplished by simulating a shock-laminar boundary layer interaction and several hypersonic flight conditions of the Pegasus(TM) launch vehicle using full artificial dissipation, low artificial dissipation, and the Engquist filter. Before the filter is applied to the PARC3D code, it is validated in one-dimensional and two-dimensional form in a MacCormack scheme against the Riemann and convergent duct problem. For this explicit scheme, the filter shows great improvements in accuracy and computational time as opposed to the nonfiltered solutions. However, for the implicit PARC3D code it is found that the best estimate of the Pegasus experimental heat fluxes and surface pressures is the simulation utilizing low artificial dissipation and no filter. The filter does improve accuracy over the artificially dissipative case but at a computational expense greater than that achieved by the low artificial dissipation case which has no computational time penalty and shows better results. For the shock-boundary layer simulation, the filter does well in terms of accuracy for a strong im-

pingement shock but not as well for weaker shock strengths. Furthermore, for the latter problem the filter reduces the required computational time to convergence by 18.7 percent.

Author

Computational Fluid Dynamics; Computer Programs; Finite Difference Theory; Heat Flux; Hypersonic Flight; Navier-stokes Equation; Nonlinear Filters; Pegasus Air-launched Booster; Simulation;

N96-16751# National Aerospace Lab., Tokyo (Japan).

Computations of flow past multi-element airfoils in wind tunnel

Nakamura, Masayoshi; Suzuki, Kouichi; Hanzawa, Asao; and Kuwano, Naoaki; 28 Nov. 1994 16 p In JAPANESE (ISSN 0389-4010)

Report No.(s): (NAL-TR-1256) Avail: CASI HC A03/MF A01

This paper presents an overview of numerical flow analyses past arbitrarily designed multi-element airfoils. Compressible unsteady inviscid flows around airfoils are analyzed by integrations of time-dependent Euler equations using finite difference techniques. Numerical solutions are obtained through an explicit upwind scheme with local time steps using a locally refined boundary modified square grid of Cartesian coordinates. In this grid, the boundary condition at curved airfoil surfaces are precisely defined by the finite difference. Numerically calculated results demonstrate two-dimensional applications for a transonic flow around a symmetrical airfoil in a free-flight condition. Other calculations for a low-speed flow around a large thickness airfoil and variations with flap and spoiler were made in a wind tunnel boundary condition. Comparisons of pressure distributions and lift coefficients were also made with other calculated solutions and with experimental data.

Author

Airfoils; Compressible Flow; Computational Fluid Dynamics; Computational Grids; Finite Difference Theory; Inviscid Flow; Transonic Flow; Unsteady Flow; Wind Tunnel Walls;

N96-16984*# Old Dominion Univ., Norfolk, VA. Dept. of Aerospace Engineering.

A two dimensional interface element for coupling of independently modeled three dimensional finite element meshes and extensions to dynamic and non-linear regimes

Aminpour, Mohammad; 1 Dec. 1995 18 p

Contract(s)/Grant(s): (NAG1-1670)

Report No.(s): (NASA-CR-199951; NAS 1.26:199951; NIPS-96-07072) Avail: CASI HC A03/MF A01

The work reported here pertains only to the first year of research for a three year proposal period. As a prelude to this two dimensional interface element, the one dimensional element was tested and errors were discovered in the code for

built-up structures and curved interfaces. These errors were corrected and the benchmark Boeing composite crown panel was analyzed successfully. A study of various splines led to the conclusion that cubic B-splines best suit this interface element application. A least squares approach combined with cubic B-splines was constructed to make a smooth function from the noisy data obtained with random error in the coordinate data points of the Boeing crown panel analysis. Preliminary investigations for the formulation of discontinuous 2-D shell and 3-D solid elements were conducted.

Derived from text

Aircraft Design; Computational Grids; Finite Element Method; Mathematical Models; Splines; Three Dimensional Models; Two Dimensional Models;

N96-17212# Washington State Univ., Pullman, WA. Dept. of Mechanical and Materials Engineering.

Vortex dynamics and separation over pitching wings Final Technical Report, 15 Jan. 1992 - 30 Jun. 1995

Ramaprian, B. R.; 31 Aug. 1995 74 p

Contract(s)/Grant(s): (F49620-92-J-0146)

Report No.(s): (AD-A299484; AFOSR-95-0645TR) Avail: CASI HC A04/MF A01

This project, aimed at an extensive study of the unsteady vortex dynamics and separation of pitching wings. Significant accomplishments were made in the project. These included extensive documentation of the 2-D velocity and vorticity field around a pitching NACA 0015 wing at a Reynolds number of 150,000, and extensive surface pressure and velocity data in the 3-D flow over a pitching swept wing of the same profile. The velocity data were obtained using the technique of Particle Image Velocimetry (PIV). The data have been used to understand the physics of 2-D and 3-D vortex dynamics separation in unsteady flows. The data have been archived carefully and will be made available to any interested user. This Final Technical Report gives a very brief summary of the Project activities.

DTIC

Aircraft Maneuvers; Boundary Layer Separation; Particle Image Velocimetry; Pitch (material); Reynolds Number; Stalling; Swept Wings; Unsteady Flow; Velocity Distribution; Vortices;

N96-17305# Army Research Lab., Aberdeen Proving Ground, MD.

Euler and Navier-Stokes simulations of shock wave interaction with a generic block target Final Report, Jan. - Nov. 1992

Schraml, Stephen J.; and Hisley, Dixie M.; Sep. 1995 40p

Report No.(s): (AD-A299958; ARL-TR-848) Avail: CASI HC A03/MF A01

A series of numerical simulations of blast wave/target interaction was performed to match a series of experiments conducted at the Centre d'Etudes de Gramat (CEG), France.

The experiments that were modeled involved a square, two-dimensional block target positioned in the vertical center of a shock tube test section and subjected to non-decaying blast waves of various amplitudes. The results of the inviscid second order hydrodynamic advanced research code (SHARC) and the viscous USA-RG2 code simulations are compared to experimentally measured pressure histories. Particular emphasis is placed on the accurate modeling of vortex formation and evolution, which influences the aerodynamic loading of the target. The viscous and inviscid results are directly compared to determine the most accurate method of modeling both diffraction and drag phase blast loading of targets.

DTIC

Blast Loads; Computerized Simulation; Euler Buckling; Hydrodynamics; Navier-stokes Equation; Shock Wave Interaction;

N96-17391# California Inst. of Tech., Pasadena, CA. Graduate Aeronautical Labs.

Interaction of chemistry, turbulence, and shock waves in hypervelocity flow Annual Progress Report

Candler, G. V.; (Minnesota Univ., Duluth, MN.)Dimotakis, P. E.; Hornung, Hans G.; Leonard, A.; Meiron, D. I.; McKoy, B. V.; Pullin, D. I.; and Sturtevant, B.; 1 Sep. 1995 82 p

Contract(s)/Grant(s): (F49620-93-1-0338)

Report No.(s): (AD-A299541; AFOSR-95-0580TR) Avail: CASI HC A05/MF A01

Significant progress was made during the second year of an interdisciplinary experimental, numerical and theoretical program to extend the state of knowledge and understanding of the effects of chemical reactions in hypervelocity flows. The program addressed key problems in aerothermochemistry that arise from interactions between the three strongly nonlinear effects: Compressibility; vorticity; and chemistry. Important new results included: Clear understanding of the two important parameters that define hypervelocity flow over spheres. Closed-form solution for standoff distance. Completion of computation of hollow-core compressible vortex streets. First high-resolution interferograms of shock-shock interaction in hypervelocity flow. Detailed experimental and theoretical study shows that high-enthalpy real-gas effects do not further increase heat flux in type 4 interaction. Interferograms establish flow quality in the hypervelocity shock tunnel T5. Upgrade of the Supersonic Shear Layer facility to higher Mach number. New results on supersonic shear layers and shear-layer/shock-wave interaction. Computational discovery of a flow field that is sensitive to vibration-dissociation coupling. Extension of the equilibrium flux method to a more robust less dissipative form and tests. Computation of collision cross section to electrons of low excited states of OH, NO, and CO₂. Establishment of Laser-Induced Thermal Acoustics as an accurate diagnostic for gas properties over large pressure ranges.

DTIC

Chemical Reactions; Compressibility; Hypervelocity; Hypervelocity Flow; Shear Layers; Shock Tunnels; Shock Waves; Turbulence; Vorticity;

N96-17457# Naval Air Warfare Center, China Lake, CA. Research and Technology Div.

Diamond dome oxidation flight boundaries Final Report, Aug. - Oct. 1994

Johnson, Curtis E.; Dow, Robert L.; and Blanchard, Douglas G.; Sep. 1995 24 p Limited Reproducibility: Document partially illegible

Report No.(s): (AD-A299815; NAWCWPNS-TP-8268) Avail: CASI HC A03/MF A01

A parametric study was conducted on the aerodynamic heating of a hypothetical hemispherical diamond dome. Flight was assumed to occur at constant altitude and Mach number. The times required for the maximum temperature on the dome to reach 800, 900, and 1000 deg C were calculated, covering the temperature range where diamond oxidation becomes rapid. The parametric matrix included altitudes from zero to 200,000 ft, and Mach numbers from 3.9 or 4.1 to 8.0. For Mach 5 at sea level, the dome would reach 800 deg C in 4.5 s, 900 deg C in 6.5 s, and 1000 deg C in 9 s, while the total (or stagnation) temperature would be about 1250 deg C. Significant temperature variations throughout the dome were calculated, especially as a function of angular position around the dome. For example, at Mach 5.5 and 20,000 ft the stagnation point of the dome reached 900 deg C in 9 s, while the edge of the dome 90 deg away was 200 deg C cooler. Oxidation would not be a concern for flights up to about Mach 4, while at Mach 5 and above flights would be limited to short durations or high altitudes. Diamond dome temperatures can also be calculated for specific flight profiles, and examples are provided for sample medium and long range anti-air missiles. These studies show that time of flight, speed, and altitude are all key parameters that would affect the oxidation of diamond domes. The information provided is valuable for assessing oxidation-limited flight conditions for diamond domes.

DTIC

Aerodynamic Heating; Diamonds; Mach Number; Oxidation;

N96-17556# Virginia Polytechnic Inst. and State Univ., Blacksburg, VA.

Post stall control of swept wings

Telionis, Demetri; 1995 85 p

Contract(s)/Grant(s): (F49620-92-J-0088)

Report No.(s): (AD-A299820; AFOSR-95-0646TR) Avail: CASI HC A05/MF A01

The work conducted on this effort is described in detail in six papers which were presented at various meetings. Copies of the papers are attached to this report. A brief descrip-

tion of this material is provided below. At the beginning of this effort, the fundamental character of the flow was investigated. In the first publication generated, we discuss the transient flow field over a delta wing during pitch-up motions to very large angles of attack. Emphasis was directed at the growth and the eventual breakdown of leading edge vortices. DTIC

Aerodynamic Stalling; Delta Wings; Swept Wings;

N96-17633# Ohio State Univ., Columbus, OH. Dept. of Mechanical Engineering.

Stability transition of high-speed flows over realistic bodies Final Report, 1 Apr. 1992 - 31 Mar. 1995

Herbert, Thorwald; 6 Sep. 1995 26 p

Contract(s)/Grant(s): (F49620-92-J-0271)

Report No.(s): (AD-A299795; AFOSR-95-0681TR) Avail: CASI HC A03/MF A01

The thrust of this research program has been the improvement of our capabilities for analyzing stability and transition in high-speed flows over realistic bodies. Examples of such bodies are swept wings of high-speed airplanes or the blunt conical bodies for hypersonic flight. We have extended the parabolized stability equations (PSE) for these situations and developed methods for solving these equations in disturbance environments typical of atmospheric conditions. Formulation, numerical methods, and program implementation have been selected toward applications in engineering practice. The PSE code has been utilized to analyze transition mechanisms in the flow over swept wings, an axisymmetric blunt cone and a sharp cone at angle of attack. Major efforts have been spent on receptivity mechanisms and on the effects of the disturbance environment on transition. Studies on the stability of 3D boundary layers suggest to replace the current tracing of discrete modes by tracing a field of modes in the flow direction.

DTIC

Boundary Layer Flow; Boundary Layer Transition; Computerized Simulation; Flight Conditions; Flow Stability; Flow Visualization; Hypersonic Flow; Mathematical Models; Supersonic Flow; Transition Flow;

03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

N96-16586*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

The Center-TRACON Automation System: Simulation and field testing

Denery, Dallas G.; and Erzberger, Heinz; Aug. 1995 20 p

Contract(s)/Grant(s): (RTOP 505-64-13)

Report No.(s): (NASA-TM-110366; A-950091; NAS 1.15:

110366) Avail: CASI HC A03/MF A01

A new concept for air traffic management in the terminal area, implemented as the Center-TRACON Automation System, has been under development at NASA Ames in a cooperative program with the FAA since 1991. The development has been strongly influenced by concurrent simulation and field site evaluations. The role of simulation and field activities in the development process will be discussed. Results of recent simulation and field tests will be presented.

Author

Air Traffic; Air Traffic Control; Automatic Control; Computerized Simulation; Trajectory Analysis;

N96-16601*# Desert Research Inst., Reno, NV. Atmospheric Sciences Center.

Part A: Cirrus ice crystal nucleation and growth. Part B: Automated analysis of aircraft ice particle data Final Report, 27 Sep. 1993 - 30 Jun. 1995

Arnott, William P.; Hallett, John; and Hudson, James G.; Jul. 1995 38 p Original contains color illustrations

Contract(s)/Grant(s): (NAG1-1546)

Report No.(s): (NASA-CR-199371; NAS 1.26:199371)

Avail: CASI HC A03/MF A01

Specific measurement of cirrus crystals by aircraft and temperature modified CN are used to specify measurements necessary to provide a basis for a conceptual model of cirrus particle formation. Key to this is the ability to measure the complete spectrum of particles at cirrus levels. The most difficult regions for such measurement is from a few to 100 microns, and uses a replicator. The details of the system to automate replicator data analysis are given, together with an example case study of the system provided from a cirrus cloud in FIRE 2, with particles detectable by replicator and FSSP, but not 2DC.

Author

Cirrus Clouds; Crystal Growth; Crystals; Ice; Image Analysis; Nucleation; Particulate Sampling;

N96-16624# General Accounting Office, Washington, DC. Resources, Community, and Economic Development Div.

Report to the Subcommittee on Transportation and Related Agencies, Committee on Appropriations, House of Representatives. Aviation security: FAA can help ensure that airports' access control systems are cost-effective

1 Mar. 1995 28 p

Report No.(s): (GAO/RCED-95-25; B-258317) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

In January 1989, as part of an effort to improve its overall strategy for preventing violent acts against airlines, FAA required that the nation's major airports install systems for controlling access to high-security areas where large passenger aircraft are located. These systems are eligible for funding under FAA's Airport Improvement Program (AIP). This

report (1) determines how much access control systems have and will cost and (2) identifies what actions FAA could take to help ensure that systems are cost-effective in the future. The variety of systems, mostly computer-controlled, installed at airports to meet FAA's access control requirements cost far more than FAA anticipated. Updated data provided by FAA show that from 1989 through 1998, the actual and projected costs for systems at the 258 airports subjected to FAA's requirements will total about \$654 million in 1993 constant dollars - over three times FAA's initial estimate. FAA can help ensure that system modernization is cost-effective by (1) providing detailed guidance explaining where equipment should be located and (2) working with the industry to develop and implement standards that provide technical criteria explaining how systems should function to meet access control requirements.

CASI

Access Control; Aircraft Safety; Airport Security; Congressional Reports; Cost Effectiveness; Government Procurement;

N96-16829# Civil Aeromedical Inst., Oklahoma City, OK. **Aircraft evacuations through type-3 exits. 2: Effects of individual subject differences Final Report**

McLean, G. A.; and George, M. H.; Aug. 1995 20 p

Contract(s)/Grant(s): (FAA PROJ. AM-B-95-PRS-89)

Report No.(s): (DOT/FAA/AM-95/25) Avail: CASI HC A03/MF A01

Simulated emergency egress from Type 3 over-wing exits was studied to support regulatory action by the FAA. Passageway width from the aircraft center aisle to the Type-3 exit was the major variable of interest; effects of individual subject attributes on egress were analyzed to determine whether such variables should be better controlled in future research. Effects of subject evacuation experience were also analyzed to account for unexpected anomalies found for age-group egress performance. Two subject groups of differing mean ages were employed in a repeated-measures evaluation of different passageway widths leading to the exit in the CAMI aircraft cabin evacuation facility. Main effects of passageway width on egress rates were determined using analysis of variance; individual subject age, weight, height, gender, and waist-size were then subjected to multivariate analysis of variance and stepwise regression analysis to assess the effects of these within-subjects factors. Repeated measures analyses of evacuations at individual passageway widths also provided information about effects of evacuation experience for individual subjects. Main effects were found for passageway width (p is less than .01), subject age (p is less than .00001), weight (p is less than .0004), waist size (p is less than .0015), and gender (p is less than .001). The stepwise regression analysis showed that individual subject age accounted for the largest amount of experimental variance (43 percent), followed next by weight, waistline size (which

correlated .89 with weight), and gender. Evacuation experience was found to enhance evacuations by allowing older subjects to develop better egress strategies and correct inefficient egress techniques. Studies of emergency aircraft evacuations should account for the personal characteristics of the individuals employed in the research, as physical attributes such as age, weight, and gender may significantly affect the results, and can be varied systematically to address certain research questions more appropriately. Similarly, research studies employing repeated measures designs can be affected by the evacuation experience subjects acquire; such studies should control for these effects to prevent the possibility of confounded results.

Author

Aircraft Compartments; Aircraft Safety; Doors; Egress; Emergencies; Evacuating (transportation); Human Factors Engineering; Passengers;

N96-16983*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

Piloted simulation tests of propulsion control as backup to loss of primary flight controls for a mid-size jet transport

Bull, John; (Caelum Research Corp., Mountain View, CA.)Mah, Robert; Davis, Gloria; Conley, Joe; Hardy, Gordon; Gibson, Jim; (Recom Technologies, Inc., San Jose, CA.)Blake, Matthew; Bryant, Don; (ManTech/NSI Technology Services Corp., Sunnyvale, CA.)and Williams, Diane; (ManTech/NSI Technology Services Corp., Sunnyvale, CA.) 1 Dec. 1995 32 p

Contract(s)/Grant(s): (RTOP 505-69-59)

Report No.(s): (NASA-TM-110374; NAS 1.15:110374; A-960631; NIPS-96-06488) Avail: CASI HC A03/MF A01

Failures of aircraft primary flight-control systems to aircraft during flight have led to catastrophic accidents with subsequent loss of lives (e.g., DC-10 crash, B-747 crash, C-5 crash, B-52 crash, and others). Dryden Flight Research Center (DFRC) investigated the use of engine thrust for emergency flight control of several airplanes, including the B-720, Lear 24, F-15, C-402, and B-747. A series of three piloted simulation tests have been conducted at Ames Research Center to investigate propulsion control for safely landing a medium size jet transport which has experienced a total primary flight-control failure. The first series of tests was completed in July 1992 and defined the best interface for the pilot commands to drive the engines. The second series of tests was completed in August 1994 and investigated propulsion controlled aircraft (PCA) display requirements and various command modes. The third series of tests was completed in May 1995 and investigated PCA full-flight envelope capabilities. This report describes the concept of a PCA, discusses pilot controls, displays, and procedures; and pres-

ents the results of piloted simulation evaluations of the concept by a cross-section of air transport pilots.

Author

Accident Prevention; Aircraft Accidents; Aircraft Landing; Flight Control; Flight Simulation; Ground Tests; Jet Aircraft; Propulsion System Performance; Thrust Control; Transport Aircraft;

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

N96-16613# General Accounting Office, Washington, DC. Resources, Community, and Economic Development Div.

Report to the Chairman, Subcommittee on Transportation and Related Agencies, Committee on Appropriations, House of Representatives. Air traffic control: Better guidance needed for deciding where to locate facilities and equipment

1 Dec. 1994 21 p

Report No.(s): (GAO/RCED-95-14; B-257921) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

This report reviews how the Federal Aviation Administration (FAA) made its decisions to locate air traffic control facilities and equipment, given its finite resources, in fiscal years 1992 through 1994 for three terminal area projects: (1) establishment of Instrument Landing Systems (ILS), which allow aircraft to approach and land at airports during adverse weather; (2) replacement of antiquated Terminal Air Traffic Control (Tower) Facilities; and (3) establishment of Digital Brite Radar Indicator Tower Equipment (D-BRITE), which assists tower controllers in identifying and sequencing traffic. The focus is on how the agency (1) prioritized locations, (2) considered the results of benefit-cost analyses in its decisions, and (3) documented all considerations that would establish a location's priority. Possible improvements in the agency's decision-making process are identified. For the three facilities and equipment projects reviewed, FAA officials funded high-priority locations in accordance with agency guidance. However, we found that FAA generally did not rank locations numerically from a national perspective, use benefit-cost analysis as a tool for ranking eligible locations, or document the factors used to select certain locations over others. Improved guidance - focusing on the need for national prioritization of locations and documentation of the factors, including the use of benefit cost analysis, that went into FAA's decisions - could help the agency better ensure the Congress and aviation system users that it is making the best

use of available funds in allocating facilities and equipment to high-priority locations.

CASI

Air Traffic Control; Airport Towers; Congressional Reports; Cost Effectiveness; Decision Making; Government Procurement; Instrument Landing Systems; Procurement Management; Surveillance Radar;

N96-17164# Federal Aviation Administration, Washington, DC.

Effect of instrument approach procedure chart design on pilot search speed and response accuracy: Flight test results Final Report, Jan. - Dec. 1994

Osborne, D. W.; Huntley, M. S.; Turner, J. W.; and Donovan, C. M.; Jun. 1995 91 p Prepared in cooperation with Unisys/EG and G Dynatrend, Cambridge, MA

Contract(s)/Grant(s): (FA5E2/A5007)

Report No.(s): (PB95-256152; DOT-VNTSC-FAA-95-13; DOT/FAA/AR-95/8) Avail: CASI HC A06/MF A02

This report describes an experiment which examined the effects of instrument approach procedure (IAP) chart design on pilot search speed and response accuracy. Ten pilots currently licensed for instrument flight participated as subjects. Pilots used charts depicted in either National Ocean Service (NOS) format or a prototype format to fly a series of instrument approaches. During these approaches, pilots were asked a set of questions pertaining the charted information. Pilots were able to find information faster on the prototype chart on the NOS chart, and they indicated a clear preference for the prototype format over the NOS format. These findings are consistent with the outcome of past research. This is the final effort in a series of evaluations by the Volpe Center Cockpit Human Factors Program to format IAP chart information to more closely conform to the way pilots actually use the information.

NTIS

Charts; Display Devices; Instrument Approach; Navigation Aids; Pilot Performance; Visual Perception;

N96-17329 State Univ. of New York at Buffalo, Amherst, NY.

Two novel approaches to navigation using the Earth's gravity and magnetic fields Ph.D. Thesis

Archibald, James Blake; 1 Jan. 1993 93 p

Report No.(s): (NIPS-96-07363) Avail: Univ. Microfilms Order No. DA9330034

Two navigation systems that exploit two of the Earth's natural fields are presented. The first exploits the Earth's gravity field, while the other utilizes the Earth's magnetic field. Part 1 presents an approach to gravity reference navigation and part 2 is concerned with a wing mounted strap-down magnetic azimuth detector. Part 1: Gravity referenced navigation. For many airborne missions precise navigation is necessary. Presently, aircraft must employ such aids as ra-

dar and Global Positioning System (GPS), to improve the overall navigation accuracy of the aircraft Inertial Navigation System (INS). Use of these types of aids could jeopardize the success of the mission because of their susceptibility to detection, jamming, and countermeasures. Presented here is a gravity referenced navigation system that employs the use of Digital Terrain Elevation Data (DTED) and a nearest neighbor neural network gravity gradient pattern matching to passively and covertly compensate for position error build up in the aircraft's INS. Presented is the system architecture, discussion of the network weight generation function, and a system simulation. Part 2: Magnetic azimuth detector for wing tip mount application. Magnetic Azimuth Detectors (MAD) currently deployed on military aircraft are unreliable and limited in their dynamic performance. The United States Air Force has issued a 'Logistic Need' requesting alternate technological approaches to solve this problem. A strap-down magnetic azimuth detector could satisfy the Air Force need due to its inherent solid state nature (no moving parts). Addressed here are the instrument performance issues of a wing tip mounted solid state MAD. The approach taken here dynamically tracks the wing tip deflections so that when used in conjunction with a fuselage mounted Inertial Reference Unit (IRU), wing tip sensed magnetic measurements can be used to derive heading. Presented is a discussion of other strapdown approaches and their shortcomings with respect to wind mounted applications. This discussion is followed by a definition of the error sources associated with the new approach and a simulation illustrating the expected performance.

Dissert. Abstr.

Air Navigation; Airborne Equipment; Computer Systems Design; Control Systems Design; Earth Gravitation; Geomagnetism; Gravitational Fields; Inertial Navigation; Navigation Aids; Systems Analysis;

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

N96-16269*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA. **Aircraft ground vibration testing at the NASA Dryden Flight Research Facility, 1993**

Kehoe, Michael W.; and Freudinger, Lawrence C.; 1 Apr. 1994 23 p Presented at the 12th International Modal Analysis Conference (IMAC), Honolulu, HI, United States, 2 Feb. 1994

Contract(s)/Grant(s): (RTOP 505-63-50)

Report No.(s): (NASA-TM-104275; NAS 1.15:104275; H-1966; NIPS-95-06837) Avail: CASI HC A03/MF A01

The NASA Dryden Flight Research Facility performs ground vibration testing to assess the structural characteristics of new and modified research vehicles. This paper updates the research activities, techniques used, and experiences in applying this technology to aircraft since 1987. Test equipment, data analysis methods, and test procedures used for typical test programs are discussed. The data presented illustrate the use of modal test and analysis in flight research programs for a variety of aircraft. This includes a technique to acquire control surface free-play measurements on the X-31 airplane more efficiently, and to assess the effects of structural modifications on the modal characteristics of an F-18 aircraft. In addition, the status and results from current research activities are presented. These data show the effectiveness of the discrete modal filter as a preprocessor to uncouple response measurements into simple single-degree-of-freedom responses, a database for the comparison of different excitation methods on a JetStar airplane, and the effect of heating on modal frequency and damping.

Author

Ground Tests; In-flight Monitoring; Research Vehicles; Spacecraft Components; Structural Design; Structural Vibration; Vibration Damping;

N96-16832 Defence Science and Technology Organisation, Melbourne (Australia). Aeronautical and Maritime Research Lab.

Vibration test on a Nomad N24A aircraft fitted with one modified aileron

Farrell, P. A.; Dunn, S. A.; and Rider, C. D.; Jun. 1995 39p
Report No.(s): (DSTO-TN-0010; AR-009-262) Copyright Avail: Issuing Activity (DSTO Aeronautical and Maritime Research Lab., PO Box 4331, Melbourne, Victoria 3001, Australia)

Following doubt raised about the loads experienced on the flap and aileron of Nomad aircraft in flight, a flight test program was formulated to measure these loads. An aileron fitted with strain gauges and the associated wiring was installed on a Nomad N24A aircraft but this rendered the aircraft non-standard. To verify the aeroelastic stability of the aircraft when fitted with the instrumented aileron, a flight flutter trial was proposed. An abbreviated Ground Vibration Test (GVT) was conducted on the aircraft to support the flutter trial, and this report describes the GVT and presents the results.

Author

Ailerons; Ground Tests; Performance Tests; Resonant Frequencies; Vibration Tests;

N96-16985*# Santa Clara Univ., CA.

Advanced methods of structural and trajectory analysis for transport aircraft Final Report, 15 Jun. 1994 - 30 Sep. 1995

Ardema, Mark D.; 30 Sep. 1995 112 p

Contract(s)/Grant(s): (NCC2-5068)

Report No.(s): (NASA-CR-199949; NAS 1.26:199949; NIPS-96-07074) Avail: CASI HC A06/MF A02

This report summarizes the efforts in two areas: (1) development of advanced methods of structural weight estimation, and (2) development of advanced methods of trajectory optimization. The majority of the effort was spent in the structural weight area. A draft of 'Analytical Fuselage and Wing Weight Estimation of Transport Aircraft', resulting from this research, is included as an appendix.

Derived from text

Aircraft Design; Estimating; Structural Weight; Trajectory Analysis; Transport Aircraft;

N96-17712*# McDonnell-Douglas Aerospace, Long Beach, CA. Transport Div.

Development of a stitched/RFI composite transport wing c05

Kropp, Yury; In NASA, Langley Research Center Mechanics of Textile Composites Conference 1 Oct. 1995 p 457-479 (For primary document see N96-17705 04-24) Avail: CASI HC A03/MF A04

Development of a composite wing primary structure for commercial transport aircraft is being undertaken at McDonnell Douglas under NASA contract. The focus of the program is to design and manufacture a low cost composite wing which can effectively compete with conventional metal wing structures in terms of cost, weight, and ability to withstand damage. These goals are being accomplished by utilizing the stitched/RFI manufacturing process during which the dry fiber preforms consisting of several stacks of warp-knit material are stitched together, impregnated with resin and cured. The stitched/RFI wing skin panels have exceptional damage tolerance and fatigue characteristics, are easily repairable, and can carry higher gross stress than their metal counterparts. This paper gives an overview of the program, describes the key features of the composite wing design and addresses major issues on analysis and manufacturing.

Author

Aircraft Construction Materials; Aircraft Design; Composite Structures; Preforms; Reinforcing Fibers; Sewing; Technology Assessment; Transport Aircraft; Wing Panels;

06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

N96-16908*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA. **In-flight demonstration of a Real-Time Flush Airdata Sensing (RT-FADS) system**

Whitmore, Stephen A.; Davis, Roy J.; and Fife, John Mi-

chael; Washington Oct. 1995 20 p Presented at the American Inst. of Aeronautics and Astronautics Atmospheric Flight Mechanics Conference, Baltimore, MD 7-10 Aug. 1995

Contract(s)/Grant(s): (RTOP 505-68-40)

Report No.(s): (NASA-TM-104314; H-2053; NAS 1.15:104314) Avail: CASI HC A03/MF A01

A prototype real-time flush airdata sensing (RT-FADS) system has been developed and flight tested at the NASA Dryden Flight Research Center. This system uses a matrix of pressure orifices on the vehicle nose to estimate airdata parameters in real time using nonlinear regression. The algorithm is robust to sensor failures and noise in the measured pressures. The RT-FADS system has been calibrated using inertial trajectory measurements that were bootstrapped for atmospheric conditions using meteorological data. Mach numbers as high as 1.6 and angles of attack greater than 45 deg have been tested. The system performance has been evaluated by comparing the RT-FADS to the ship system airdata computer measurements to give a quantitative evaluation relative to an accepted measurement standard. Nominal agreements of approximately 0.003 in Mach number and 0.20 deg in angle of attack and angle of sideslip have been achieved.

Author

Air Data Systems; Algorithms; Flight Tests; Nonintrusive Measurement; Onboard Data Processing; Pressure Sensors; Real Time Operation;

07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

N96-16266*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

Static flow characteristics of a mass flow injecting valve Mattern, Duane; (NYMA, Inc., Brook Park, OH.) and Paxson, Dan; 1 Nov. 1995 16 p

Contract(s)/Grant(s): (NAS3-25266; RTOP 505-62-50)

Report No.(s): (NASA-TM-107072; NAS 1.15:107072; E-9936; NIPS-95-06833) Avail: CASI HC A03/MF A01

A sleeve valve is under development for ground-based forced response testing of air compression systems. This valve will be used to inject air and to impart momentum to the flow inside the first stage of a multi-stage compressor. The valve was designed to deliver a maximum mass flow of 0.22 lbm/s (0.1 kg/s) with a maximum valve throat area of 0.12 sq. in (80 sq. mm), a 100 psid (689 KPA) pressure difference across the valve and a 68 F, (20 C) air supply. It was assumed that the valve mass flow rate would be proportional to the valve orifice area. A static flow calibration revealed a nonlinear valve orifice area to mass flow relationship

which limits the maximum flow rate that the valve can deliver. This nonlinearity was found to be caused by multiple choking points in the flow path. A simple model was used to explain this nonlinearity and the model was compared to the static flow calibration data. Only steady flow data is presented here. In this report, the static flow characteristics of a proportionally controlled sleeve valve are modelled and validated against experimental data.

Author

Design Analysis; Flow Characteristics; Orifice Flow; Static Characteristics; Steady Flow; Turbocompressors; Valves;

N96-16275*# NYMA, Inc., Brook Park, OH.

PARC3D calculations of the F/A-18A HARV inlet vortex generators Final Report

Podleski, Steve D.; Cleveland, OH United States NASA. Lewis Research Center 1 Nov. 1995 56 p

Contract(s)/Grant(s): (NAS3-27186; RTOP 505-68-30)

Report No.(s): (NASA-CR-195456; NAS 1.26:195456 E-9744; NIPS-95-06844) Avail: CASI HC A04/MF A01

NASA Lewis Research Center is currently engaged in a research effort as a team member of the High Alpha Technology Program within the NASA agency. This program uses a specially-equipped F/A-18A aircraft called the High Alpha Research Vehicle (HARV), in an effort to improve the maneuverability of high performance military aircraft at low-subsonic-speed, high-angle-of-attack conditions. The overall objective of the NASA Lewis effort is to develop inlet analysis technology towards efficient airflow delivery to the engine during these maneuvers. One portion of this inlet analysis technology uses computational fluid dynamics to predict installed inlet performance. Most of the F/A-18A HARV geometry, which includes the ramp/splitter plate, side diverter and slot, inlet lip and upper diverter, and deflected leading-edge flap has been modeled. The empennage and rear fuselage have not. A pair of vortex generators located on the bottom wall of the inlet were not modeled initially. These vortex generators were installed to alleviate any flow separation that may be induced by the wheel well protrusion into the inlet wall. Calculations completed with the PARC3D code showed that the pressure recovery has been underpredicted and the flow distortion over-predicted. To improve the correlation of PARC3D predictions with flight and wind tunnel tests, the vortex generators were included in the grid geometry and the results are presented in this report. The grid totals 27 blocks or 1.3 million grid points for the half model, which includes the vortex generator grid blocks. Two flight cases were calculated, a high speed case with a Mach number of 0.8 and angle of attack of 3.4; and a low speed case with a Mach number of 0.43 and angle of attack of 32.2. The vortex generators have a significant effect on the inlet boundary layers at high speed, low angle of attack; and have no effect at low speed, high angle of attack.

Author

Applications Programs (computers); Computational Fluid Dynamics; Computational Grids; Engine Inlets; F-18 Aircraft; Flow Distortion; Maneuverability; Research Vehicles; Separated Flow; Transonic Speed; Vortex Generators;

N96-16606*# General Electric Co., Lynn, MA. Aircraft Engines.

Wide speed range turboshaft study

Dangelo, Martin; Aug. 1995 43 p

Contract(s)/Grant(s): (NAS3-25951; RTOP 505-69-10)

Report No.(s): (NASA-CR-198380; E-9860; NAS 1.26: 198380) Avail: CASI HC A03/MF A01

NASA-Lewis and NASA-Ames have sponsored a series of studies over the last few years to identify key high speed rotorcraft propulsion and airframe technologies. NASA concluded from these studies that for near term aircraft with cruise speeds up to 450 kt, tilting rotor rotorcraft concepts are the most economical and technologically viable. The propulsion issues critical to tilting rotor rotorcraft are: (1) high speed cruise propulsion system efficiency and (2) adequate power to hover safely with one engine inoperative. High speed cruise propeller efficiency can be dramatically improved by reducing rotor speed, yet high rotor speed is critical for good hover performance. With a conventional turboshaft, this wide range of power turbine operating speeds would result in poor engine performance at one or more of these critical operating conditions. This study identifies several wide speed range turboshaft concepts, and analyzes their potential to improve performance at the diverse cruise and hover operating conditions. Many unique concepts were examined, and the selected concepts are simple, low cost, relatively low risk, and entirely contained within the power turbine. These power turbine concepts contain unique, incidence tolerant airfoil designs that allow the engine to cruise efficiently at 51 percent of the hover rotor speed. Overall propulsion system efficiency in cruise is improved as much as 14 percent, with similar improvements in engine weight and cost. The study is composed of a propulsion requirement survey, a concept screening study, a preliminary definition and evaluation of selected concepts, and identification of key technologies and development needs. In addition, a civil transport tilting rotor rotorcraft mission analysis was performed to show the benefit of these concepts versus a conventional turboshaft. Other potential applications for this technology are discussed.

Author

Cruising Flight; Engine Design; Gas Turbine Engines; Hovering; Propeller Efficiency; Rotor Speed; Tilt Rotor Aircraft; Tilting Rotors; Transport Aircraft; Turboshafts;

N96-16848# Florida State Univ., Tallahassee, FL. Dept. of Mechanical Engineering.

Thrust vector control of rectangular jets using counter-

flow Final Report, 1 Feb. 1994 - 30 Apr. 1995

Krothapalli, A.; and Forliti, D. J.; 7 Jul. 1995 135 p

Contract(s)/Grant(s): (F49620-94-1-0159)

Report No.(s): (AD-A299590; FMRL-TR-95-1; AFOSR-95-0642TR) Avail: CASI HC A07/MF A02

This research studied the flow generated by a rectangular convergent-divergent Mach 2 nozzle operated in a free jet and a counterflow thrust vectored configuration. Particle Image Velocimetry was used to obtain 2D velocity fields and total and static pressures were measured. In the free jet configuration, the nozzle was operated at ideal, over, and under-expanded conditions. The growth of shear layers was unaffected by shock cells for mildly off-design conditions. The thrust vector configuration is similar to an ejector, where suction is applied to one side of the jet. This creates a cross-stream pressure gradient resulting in a vectoring of the jet. The application of suction creates counterflow. This gives the jet a streamwise curvature, the destabilizing nature of which causes an increase in the growth of the non-suction side of the shear layer. The suction side shear layer experiences counterflow and both destabilizing and stabilizing curvature. It becomes thicker with suction, suggesting a self-excited state. The development of large scale structures when suction is applied gives further evidence of self-excitation. These structures cause enhanced mixing resulting in the cross-stream pressure gradient which leads to vectoring.

DTIC

Convergent-divergent Nozzles; Counterflow; Free Jets; Particle Image Velocimetry; Self Excitation; Static Pressure; Supersonic Speed; Thrust Vector Control; Velocity Distribution;

N96-17214# California Inst. of Tech., Pasadena, CA.

Shock enhancement and control of hypersonic combustion Final Report, 15 Nov. 1989 - 30 Sep. 1994

Marble, Frank E.; and Zukoski, Edward E.; 6 Dec. 1994 51p

Contract(s)/Grant(s): (AF-AFOSR-0188-90)

Report No.(s): (AD-A299492; AFOSR-95-0601TR) Avail: CASI HC A04/MF A01

It is proposed to enhance the rate of mixing and combustion of hydrogen and air, and thereby reduce combustor length of scramjet combustors, through the introduction of stream wise vorticity generated by the interaction of a weak oblique shock wave with the density gradient between air and a cylindrical jet of hydrogen. Because of the high Mach number flow the combustor, the oblique shock traverses the jet a very small angle and the principle of slender body theory allows one to replace the three-dimensional steady flow with a two-dimensional unsteady flow. As a consequence, two-dimensional time-dependent computational studies and an extensive experimental shock tube investigation were employed to assess mixing rates for the steady flow in the combustor. The results indicated that under realistic

conditions, adequate mixing could be accomplished within one millisecond.

DTIC

Augmentation; Combustion Chambers; Cylindrical Bodies; Hypersonic Combustion; Mach Number; Oblique Shock Waves; Slender Bodies; Supersonic Combustion Ramjet Engines; Three Dimensional Flow; Two Dimensional Flow; Vorticity;

N96-17317# Minnesota Univ., Minneapolis, MN. Office of Research and Technology Transfer Administration.

Thrust vector control of rectangular jets using counter-flow Final Technical Report, 1 Jan. 1994 - 30 Jun. 1995

Vanderveer, Michael R.; and Strykowski, Paul J.; 31 Aug. 1995 141 p

Contract(s)/Grant(s): (F49620-94-1-0046)

Report No.(s): (AD-A299698; AFOSR-95-0639TR) Avail: CASI HC A07/MF A02

Fluidic vectoring of a subsonic jet was examined using a curved countercurrent mixing layer. A rectangular jet having a 4:1 aspect ratio was studied at Mach numbers up to 0.5 at a stagnation temperature of 300 K. Several different curved control surfaces called 'collars' were placed downstream of the nozzle exit over which the pressure forces could act to produce jet thrust vectoring. Results showed that by applying counterflow over the collar surface, the entrainment characteristics of the jet shear layer could be altered, thereby establishing the cross stream pressure gradient necessary to achieve continuous thrust vectoring up to 220. Under certain conditions, however, continuous thrust vector control was lost, causing jet attachment to the collar. This condition resulted in a strong hysteresis loop which demanded that the suction be reduced considerably before the jet detached from the collar surface. Since such bistability was undesirable for applications requiring continuous control, the phenomenon was studied in detail. Optimization of the collar geometry was shown to delay jet attachment, creating a larger regime of smooth and continuous vectoring.

DTIC

Axisymmetric Flow; Boundary Layer Flow; Convergent-divergent Nozzles; Counterflow; Gas Jets; Inviscid Flow; Jet Mixing Flow; Mach Number; Nozzles; Subsonic Flow; Thrust Vector Control; Two Dimensional Flow;

N96-17340*# Allison Engine Co., Indianapolis, IN.

TADS: A CFD-based turbomachinery and analysis design system with GUI. Volume 2: User's manual Final Report

Myers, R. A.; Topp, D. A.; and Delaney, R. A.; 1 Dec. 1995 80 p

Contract(s)/Grant(s): (NAS3-25950; RTOP 505-62-10)

Report No.(s): (NASA-CR-198441; NAS 1.26:198441; E-10059; NIPS-96-06878) Avail: CASI HC A05/MF A01

The primary objective of this study was the development of a computational fluid dynamics (CFD) based turbomachinery airfoil analysis and design system, controlled by a graphical user interface (GUI). The computer codes resulting from this effort are referred to as the Turbomachinery Analysis and Design System (TADS). This document is intended to serve as a user's manual for the computer programs which comprise the TADS system. TADS couples a throughflow solver (ADPAC) with a quasi-3D blade-to-blade solver (RVCQ3D) in an interactive package. Throughflow analysis capability was developed in ADPAC through the addition of blade force and blockage terms to the governing equations. A GUI was developed to simplify user input and automate the many tasks required to perform turbomachinery analysis and design. The coupling of various programs was done in a way that alternative solvers or grid generators could be easily incorporated into the TADS framework.

Author (revised)

Airfoils; Applications Programs (computers); Cascade Flow; Computational Fluid Dynamics; Computer Aided Design; Graphical User Interface; Turbomachine Blades; User Manuals (computer Programs);

N96-17344*# Allison Engine Co., Indianapolis, IN.

TADS: A CFD-based turbomachinery and analysis design system with GUI. Volume 1: Method and results Final Report

Topp, D. A.; Myers, R. A.; and Delaney, R. A.; 1 Dec. 1995 121 p

Contract(s)/Grant(s): (NAS3-25950; RTOP 505-62-10)

Report No.(s): (NASA-CR-198440; NAS 1.26:198440; E-10058; NIPS-96-06885) Avail: CASI HC A06/MF A02

The primary objective of this study was the development of a computational fluid dynamics (CFD) based turbomachinery airfoil analysis and design system, controlled by a graphical user interface (GUI). The computer codes resulting from this effort are referred to as the Turbomachinery Analysis and Design System (TADS). This document describes the theoretical basis and analytical results from the TADS system. TADS couples a throughflow solver (ADPAC) with a quasi-3D blade-to-blade solver (RVCQ3D) in an interactive package. Throughflow analysis capability was developed in ADPAC through the addition of blade force and blockage terms to the governing equations. A GUI was developed to simplify user input and automate the many tasks required to perform turbomachinery analysis and design. The coupling of various programs was done in a way that alternative solvers or grid generators could be easily incorporated into the TADS framework. Results of aerodynamic calculations using the TADS system are presented for a highly loaded fan, a compressor stator, a low-speed turbine blade, and a transonic turbine vane.

Author

Airfoils; Applications Programs (computers); Cascade

Flow; Computational Fluid Dynamics; Computer Aided Design; Graphical User Interface; Turbomachine Blades;

N96-17637# Massachusetts Inst. of Tech., Cambridge, MA. Gas Turbine Lab.

Air Force Research in Aero Propulsion Technology (AFRAPT) Final Technical Report, 1 Sep. 1993 - 31 Mar. 1995

Greitzer, Edward M.; Epstein, Alan H.; Ingard, K. Uno; Tan, Choon S.; and Waitz, Ian A.; 3 Apr. 1995 17 p

Contract(s)/Grant(s): (AF-AFOSR-0052-91)

Report No.(s): (AD-A299838; AFOSR-95-0635TR) Avail: CASI HC A03/MF A01

This report covers research performed under Grant AFOSR-91-0052. The work consisted of five separate projects: (1) Active Control of Jet Engine Surge; (2) Turbomachinery Vortical Flows in an Adverse Pressure Gradient; (3) Enhanced Mixing Using Embedded Streamwise Vorticity; (4) Rotor-Stator Interaction and Turbomachinery Stall Behavior; and (5) Suction and Blowing Strategies for Fan Noise Reduction.

DTIC

Active Control; Aerodynamic Noise; Aerodynamic Stalling; Computational Fluid Dynamics; Heat Transfer; Jet Engines; Noise Reduction; Propulsion System Performance; Rotor Dynamics; Turbomachinery; Unsteady Flow;

08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

N96-16755# Princeton Univ., NJ.

The effect of inflow models on the dynamic response of helicopters

Arnold, U. T. P.; Keller, J. D.; and Curtiss, H. C.; 1 Sep. 1995 15 p Presented at the 21st European Rotocraft Forum, Saint-Petersburg, Russia, 30 Aug. - 1 Sep. 1995 Avail: CASI HC A03/MF A01

This paper examines in detail some modifications to the main rotor aerodynamic modeling that will effect the off axis response of a helicopter. Three different approaches are examined: an extended version of momentum theory including wake distortion terms, a first-order aerodynamic lag model, and an aerodynamic phase correction. It is shown that all three approaches result in similar off-axis responses when applied to a simplified model of the coupled pitch-roll dynamics in hover. Numerical values for the inflow parameters are determined using system identification and are compared to theoretical predictions and previously identified values. Comparisons are also made between a nonlinear simulation model with extended momentum theory and flight test data for a UH-60 in hover, demonstrating considerable improvement in the off-axis response prediction.

Author

Aerodynamic Characteristics; Dynamic Response; Helicopter Performance; Helicopters; Momentum Theory; Performance Prediction; Rotor Aerodynamics;

N96-17328 Minnesota Univ., Minneapolis, MN.

Control design for aircraft using robust dynamic inversion technique Ph.D. Thesis

Reiner, Jacob; 1 Jan. 1993 185 p

Report No.(s): (NIPS-96-07351) Avail: Univ. Microfilms Order No. DA9331936

A combined mu synthesis and dynamic inversion approach was applied to the design of feedback control laws for the longitudinal dynamics of the High Angle-of-Attack Research Vehicle (HARV). The aircraft is capable of flight at very high angles-of-attack and has thrust vectoring as well as conventional aerodynamic control surfaces. The objective of the research was to develop a method for design of flight controllers which provide desired handling qualities over a wide range of flight conditions with minimal scheduling. These controllers must also exhibit stability and performance robustness to modeling errors. Dynamic inversion was used to design an inner loop controller which linearized the transfer function from a desired input to a specified output. Since the inner loop did not achieve perfect linearization due to modeling and measurement errors, an error model of the system with the inner loop closed was constructed. This error model was used in the design formulation for a mu synthesis outer loop controller which minimized the structured singular value (mu) of the error between the desired handling quality model and the actual aircraft response. Both, pitch rate and angle-of-attack command following systems were designed. Nonlinear simulations demonstrated that both controllers satisfied linear handling qualities specifications, provided excellent tracking of pilot commands and exhibited excellent robustness over a wide range of angles-of-attack and Mach numbers. The controllers required no scheduling with flight conditions.

Dissert. Abstr.

Angle of Attack; Control Systems Design; Controllers; Feedback Control; Flight Control; Inversions; Longitudinal Control; Research Vehicles; Robustness (mathematics); Thrust Vector Control;

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

N96-16296# Maryland Univ., College Park, MD. Dept. of Civil Engineering.

Vertiport capacity: Analysis methods Final Report

Kim, Yeon-Myung; Schonfeld, Paul; and Rakas, Jasenka; Aug. 1995 76 p

Report No.(s): (DOT/FAA/ND-95/3) Avail: CASI HC A05/MF A01

This report presents a methodology for analyzing vertiport capacity and delays. Based on available information, deterministic models were developed to estimate vertiport capacity, analytic queuing models were developed to estimate the delays at vertiports during steady demand periods, and simulation models were developed to estimate delays during peak periods when traffic exceeds capacity. A practical capacity, defined as that traffic volume at which average delays are four minutes per operation, can be determined from a volume versus delay curve. Results show that vertiport capacity is more likely to be limited by airspace separations or gate availability than by touchdown and liftoff area (TLOF) occupancy times. Equations are provided for estimating relations among aircraft arrival rates, required number of gates, and gate occupancy times. These may be used to determine the required number of TLOF's or gates in particular situations.

Author

Air Traffic; Airport Planning; Delay; Heliports; Tilt Rotor Aircraft; Vertical Landing; Vertical Takeoff;

N96-16833*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

User manual for NASA Lewis 10 by 10 foot supersonic wind tunnel

Soeder, Ronald H.; Nov. 1995 54 p Revised

Contract(s)/Grant(s): (RTOP 505-62-84)

Report No.(s): (NASA-TM-105626; E-6967; NAS 1.15: 105626) Avail: CASI HC A04/MF A01

This manual describes the 10- by 10-Foot Supersonic Wind Tunnel at the NASA Lewis Research Center and provides information for users who wish to conduct experiments in this facility. Tunnel performance operating envelopes of altitude, dynamic pressure, Reynolds number, total pressure, and total temperature as a function of test section Mach number are presented. Operating envelopes are shown for both the aerodynamic (closed) cycle and the propulsion (open) cycle. The tunnel test section Mach number range is 2.0 to 3.5. General support systems, such as air systems, hydraulic system, hydrogen system, fuel system, and Schlieren system, are described. Instrumentation and data processing and acquisition systems are also described. Pretest meeting formats and schedules are outlined. Tunnel user responsibility and personnel safety are also discussed.

Author

Dynamic Pressure; Mach Number; Performance Tests; Re-

ynolds Number; Supersonic Wind Tunnels; User Manuals (computer Programs); Wind Tunnel Tests;

N96-17529# National Oceanic and Atmospheric Administration, Boulder, CO. Aeronomy Lab.

Current status of the Flatland Atmospheric Observatory c09

Clark, W. L.; Warnock, J. M.; Vanzandt, T. E.; Gage, K. S.; Ecklund, W. L.; Carter, D. A.; Nastrom, G. D.; (Saint Cloud State Coll., MN.) Johnston, P. E.; (Colorado Univ., Boulder, CO.) and Henson, S. W.; (Illinois Univ., Urbana, IL.) In National Central Univ., Solar-Terrestrial Energy Program: Proceedings of the 6th Workshop on Technical and Scientific Aspects of MST Radar 20 Aug. 1993 p 357-360 (For primary document see N96-17458 04-32) Avail: CASI HC A01/MF A04; NOAA, 325 Broadway, Boulder, CO 80303

The Flatland Atmospheric Observatory (FAO), supported jointly by the United States Department of Commerce National Oceanic and Atmospheric Administration and the United States National Science Foundation, is located on a University of Illinois field site near Champaign/Urbana, Illinois. This is a region well suited to the study of atmospheric dynamics with minimal orographic influences. The principal instrument of FAO is the Flatland VHF Radar (FVR). This 49.8 MHz clear-air Doppler radar, or Wind Profiler, typically observes 3 dimensional tropospheric wind profiles about once every 5 minutes, utilizing time multiplexing of 6 different beam positions. Usual parameter settings are listed in Table 1, although the system is quite flexible in choice of operational modes. To supplement the FVR, a UHF 915 MHz Doppler radar (FUR) has been added, providing wind observation at lower altitudes than FVR is currently capable of. This system has a similar choice of beam positions and beam widths as FVR, facilitating dual frequency experiments. FUR also has RASS capability (Ecklund et al. 1993), thus providing temperature profiles through the boundary layer. Perhaps the most notable of the dual frequency capabilities now possible is the study of methods to remotely sensing precipitation properties, including drop size distribution and rain rate (Rogers et al. 1993). Conversely, this dual frequency capability allows study of the extent to which hydrometeors may influence 'clear air' measurements, a topic crucial to the radar determination of long-term or large-scale vertical bulk motion, discussed in several papers at this workshop, including (Nastrom et al. 1993a & b, McAfee et al. 1993a & b, and Clark et al. 1993). Typical parameter settings for the FUR system are also listed. A meteorological surface station has been installed, providing an observation of the surface wind speed and direction, solar flux, temperature, relative humidity, and rain rate approximately every 30 s synchronously with each FUR wind and reflectivity sounding. An eight station digital-barometer network has been installed and is operated with joint NASA/GSFC and NOAA support to provide space-time information not available in

the single station radar data. Since November 1991, 2 minute means of pressure have been recorded and archived continuously. These data are particularly useful in the study of gravity waves (e.g., VanZandt et al. 1993) and tides (Clark et al., 1993). Finally, a radiosonde balloon receiving system became operational at the site in January 1991 for use in special campaigns. This system measures height profiles of pressure, temperature, and humidity with up to 7 meter height resolution from the surface to about 20 km MSI.

Derived from text

Assessments; Atmospheric Boundary Layer; Atmospheric Physics; Doppler Radar; Ground Wind; Illinois; Meteorological Radar; Observatories; Rain; Temperature Profiles; Troposphere; Wind Profiles; Wind Velocity;

N96-17537# National Central Univ., Chung-Li (Taiwan).
A status report of the NSC Chung-Li Instrument Center c09

Su, S.-Y.; Chen, Y. H.; Pan, C. J.; Liu, C. H.; Roettger, J.; (EISCAT Scientific Association, Kiruna, Sweden.) and Franke, S. J.; (Illinois Univ., Urbana, IL.) In its Solar-Terrestrial Energy Program: Proceedings of the 6th Workshop on Technical and Scientific Aspects of MST Radar 20 Aug. 1993 p 387-389 (For primary document see N96-17458 04-32) Avail: CASI HC A01/MF A04; NOAA, 325 Broadway, Boulder, CO 80303

It has been ten years since the initiation of building the Chung-Li VHF radar facility. As of now, the original antenna arrays have been refurbished and the radar hardware has been upgraded to reflect new technologies in RF electronics. Except for the three transmitters and the phase locker, the receiver, radar controller, data acquisition and data logging system have all been upgraded. The new system can observe atmospheric and ionospheric phenomena with temporal variation of orders of milli-seconds. This report will present some initial observations made with the new improved Chung-Li radar facilities.

Author

Coherent Radar; Data Acquisition; Earth Ionosphere; Ionospheric Sounding; Radar Data; Radar Tracking;

10 ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

N96-17077*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

Third NASA Workshop on Wiring for Space Applications

Hammoud, Ahmad; comp. and Stavnes, Mark; comp. 1 Nov. 1995 233 p Workshop held in Cleveland, OH, 18-19 Jul. 1995; sponsored by NASA Washington Original contains color illustrations

Contract(s)/Grant(s): (RTOP 297-50-00)

Report No.(s): (NASA-CP-10177; NAS 1.55:10177; E-9946; NIPS-96-06247) Avail: CASI HC A11/MF A03; 2 functional color pages

This workshop addressed key technology issues in the field of electrical power wiring for space applications, and transferred information and technology related to space wiring for use in government and commercial applications. Speakers from space agencies, U.S. Federal labs, industry, and academia presented program overviews and discussed topics on arc tracking phenomena, advancements in insulation materials and constructions, and new wiring system topologies. For individual titles, see N96-17078 through N96-17098.

Aircraft Reliability; Circuit Reliability; Electric Arcs; Electric Wire; Electrical Insulation; Power Supply Circuits; Spacecraft Reliability;

11 CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; non-metallic materials; and propellants and fuels.

N96-16272*# Lockheed Martin Engineering and Sciences Co., Hampton, VA.

A record of all marker bands found in the upper rivet rows of 2 adjacent bays from a fuselage lap splice joint

Willard, Scott A.; 1 Nov. 1995 49 p

Contract(s)/Grant(s): (NAS1-19000; RTOP 505-63-50-04)

Report No.(s): (NASA-CR-198249; NAS 1.26:198249; NIPS-95-06841) Avail: CASI HC A03/MF A01

A full scale fuselage test article was subjected to 60,000 load cycles (pressurizations) to study the effect of widespread fatigue damage in fuselage structures. Every 10,000 cycles coded marker block loading sequences were used to mark the fracture surfaces of the fatigue cracks propagating within the panel. The loading sequences consisted of series of underloads combined with a series of full pressurizations. The combination of loads and underloads marked the fracture surfaces with marker bands that could later be used to reconstruct the fatigue crack growth history of selected regions within the test article. Thirty rivet holes comprising the upper rivet rows from two adjacent bays (bays #3 and #4) from a fuselage lap splice joint were examined for the purpose of this study. Optical and scanning electron microscopy (SEM) were used to locate the marker bands.

Author

Cracking (fracturing); Fatigue (materials); Fatigue Tests; Full Scale Tests; Fuselages; Load Tests; Markers;

N96-16572*# Virginia Univ., Charlottesville, VA. Dept. of Material Science and Engineering.

NASA-UVA Light Aerospace Alloy and Structures Technology program (LA2ST) Progress Report, 1 Jan. 1995 - 30 Jun. 1995

Starke, Jr., Edgar A.; Gangloff, Richard P.; Herakovich, Carl T.; Scully, John R.; Shiflet, Gary J.; Stoner, Glenn E.; and Wert, John A.; Jul. 1995 343 p

Contract(s)/Grant(s): (NAG1-745)

Report No.(s): (NASA-CR-198914; NAS 1.26:198914; UVA/528266/MS95/118) Avail: CASI HC A15/MF A03

The objective of the LA2ST Program is to conduct interdisciplinary graduate student research on the performance of next generation, light-weight aerospace alloys, composites, and thermal gradient structures in collaboration with NASA-Langley researchers. The general aim is to produce relevant data and basic understanding of material mechanical response, environment/corrosion behavior, and microstructure; new monolithic and composite alloys; advanced processing methods; new solid and fluid mechanics analyses; measurement and modeling advances; and a pool of educated students for aerospace technologies. Specific technical objectives are presented for each of the following research projects: time-temperature dependent fracture in advanced wrought ingot metallurgy, and spray deposited aluminum alloys; cryogenic temperature effects on the deformation and fracture of Al-Li-Cu-In alloys; effects of aging and temperature on the ductile fracture of AA2095 and AA2195; mechanisms of localized corrosion in alloys 2090 and 2095; hydrogen interactions in aluminum-lithium alloys 2090 and selected model alloys; mechanisms of deformation and fracture in high strength titanium alloys (effects of temperature and hydrogen and effects of temperature and microstructure); evaluations of wide-panel aluminum alloy extrusions; Al-Si-Ge alloy development; effects of texture and precipitates on mechanical property anisotropy of Al-Cu-Mg-X alloys; damage evolution in polymeric composites; and environmental effects in fatigue life prediction - modeling crack propagation in light aerospace alloys.

CASI

Aircraft Construction Materials; Aircraft Structures; Aluminum Alloys; Fatigue Life; Fracture Mechanics; Fracture Strength; Hydrogen Embrittlement; Light Alloys; Stress Corrosion Cracking; Titanium Alloys;

N96-17381 Environmental Protection Agency, Cincinnati, OH. National Risk Management Research Lab.

Advanced composites technology case study at NASA Langley Research Center

Stone, K. R.; and Springer, J.; Aug. 1995 45 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

Report No.(s): (PB95-264172; EPA/600/R-95/138) Avail: CASI HC A03

This assessment was focused on the production of non-refractory composite materials and aircraft structures made from those materials. The prepregging process represents one of the first steps in the manufacture of composite materials. During prepregging, carbon-based fiber tow bundles are impregnated with a plastic polymer powder to produce tow-preg materials, which can then be formed and finished into plastic composites. The new prepregging process evaluated in this report has the potential to reduce air emissions, solid wastes, and hazardous wastes during the manufacture of prepreg materials.

NTIS

Aircraft Structures; Carbon Fibers; Composite Materials; Composite Structures; Impregnating;

N96-17427# General Electric Co., Schenectady, NY. Research and Development Center.

Development and assessment of turbulence-chemistry models in highly strained non-premixed flames Final Report, 1 Oct. 1991 - 30 Sep. 1994

Correa, Sanjay M.; 31 Oct. 1994 56 p

Contract(s)/Grant(s): (F49620-91-C-0072; AF PROJ. 2308)

Report No.(s): (AD-A299782; REPT-94SRD008; AFOSR-95-0581TR) Avail: CASI HC A04/MF A01

The goal of this research is a quantitative understanding of turbulence-chemistry interactions as they pertain to combustion in aeropropulsion engines. The two principal classes of accomplishment are: (1) The first-ever stochastic joint velocity-composition pdf simulations of bluff-body stabilized flames, and comparison with Raman data on major species, temperature and mixture fraction (mean and rms quantities of each) in the same burner. Fuels have been CO/H₂ mixtures (whose reduced chemistry is modeled with two compositional variables) and methane (five variables). This method of merging pdf transport and CFD codes can be used to combine the pdf model with any of the CFD codes used in design. There is thus a clear path for transitioning the results of the research. Remaining issues included a chemistry scheme for jet fuels (not just CO/H₂ and CH₄), tested in turbulence and not only in the laminar context, and more species and temperature data in the regime of high turbulence intensity, so that the model can be tested in the regime of real engines; and (2) The 'Partially Stirred Reactor' or PaSR model was developed toward the first two of these goals. The unsteady evolution of a full chemistry scheme is computed in the presence of turbulence of prescribed frequency.

DTIC

Combustion Chemistry; Computational Fluid Dynamics; Flames; Jet Engine Fuels; Laminar Flow; Models; Probability Density Functions; Raman Spectra; Stochastic Processes; Turbulence;

N96-17711*# Lockheed Aeronautical Systems Co., Marietta, GA.

Textile technology development c24

Shah, Bharat M.; In NASA, Langley Research Center Mechanics of Textile Composites Conference 1 Oct. 1995 p 425-455 (For primary document see N96-17705 04-24) Avail: CASI HC A03/MF A04

The objectives of this report were to evaluate and select resin systems for Resin Transfer Molding (RTM) and Powder Towpreg Material, to develop and evaluate advanced textile processes by comparing 2-D and 3-D braiding for fuselage frame applications and develop window belt and side panel structural design concepts, to evaluate textile material properties, and to develop low cost manufacturing and tooling processes for the automated manufacturing of fuselage primary structures. This research was in support of the NASA and Langley Research Center (LaRc) Advanced Composite Structural Concepts and Materials Technologies for Primary Aircraft Structures program.

CASI

Braided Composites; Composite Structures; Computer Aided Design; Fuselages; Panels; Performance Prediction; Powder (particles); Preforms; Resin Transfer Molding; Textiles; Three Dimensional Composites; Two Dimensional Bodies; Woven Composites;

12 ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

N96-16226*# Old Dominion Univ., Norfolk, VA.

Methodology for simulation of unsteady flows to determine the time-dependent interference between stationary and moving boundaries

Singh, Kamakhya Prasad; 1 Jan. 1995 2 p

Contract(s)/Grant(s): (NAG1-1499)

Report No.(s): (NASA-CR-199779; NAS 1.26:199779; NIPS-95-06450) Avail: CASI HC A01/MF A01; Abstract Only

A new methodology is developed to simulate unsteady flows about prescribed and aerodynamically determined moving boundary problems. The method couples the fluid dynamics and rigid-body dynamics equations to capture the time-dependent interference between stationary and moving boundaries. The unsteady, compressible, inviscid (Euler) equations are solved on dynamic, unstructured grids by an explicit, finite-volume, upwind method. For efficiency, the grid adaptation is performed within a window around the moving object. The Eulerian equations of the rigid-body dy-

namics are solved by a Runge-Kutta method in a non-inertial frame of reference. The two-dimensional flow solver is validated by computing the flow past a sinusoidally-pitching airfoil and comparing these results with the experimental data. The overall methodology is used for two two-dimensional examples: the flow past an airfoil which is performing a three-degrees-of-freedom motion in a transonic freestream, and the free-fall of a store after separation from a wing-section. Then the unstructured mesh methodology is extended to three-dimensions to simulate unsteady flow past bodies in relative motion, where the trajectory is determined from the instantaneous aerodynamics. The flow solver and the adaptation scheme in three dimensions are validated by simulating the transonic, unsteady flow around a wing undergoing a forced, periodic, pitching motion, and comparing the results with the experimental data. To validate the trajectory code, the six-degrees-of-freedom motion of a store separating from a wing was computed using the experimentally determined force and moment fields, then comparing with an independently generated trajectory. Finally, the overall methodology was demonstrated by simulating the unsteady flowfield and the trajectory of a store dropped from a wing. The methodology, its computational cost notwithstanding, has proven to be accurate, automated, easy for dynamic gridding, and relatively efficient for the required man-hours.

Author

Boundary Value Problems; Computational Fluid Dynamics; Euler Equations of Motion; Fluid Dynamics; Inviscid Flow; Time Dependence; Unsteady Flow;

N96-16229*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

Analysis of selected compression splice joint locations in a graphite-epoxy transport wing stub box

Jegley, Dawn C.; 1 Oct. 1995 34 p

Contract(s)/Grant(s): (RTOP 510-02-12-01)

Report No.(s): (NASA-TM-110170; NAS 1.15:110170; NIPS-95-06489) Avail: CASI HC A03/MF A01

Three critical compression splice joint locations in a stitched graphite-epoxy transport wing stub box have been analyzed to determine their expected structural performance. The wing box is representative of a section of a commercial transport wing box and was designed and constructed by McDonnell Douglas Aerospace Company as part of the NASA Advanced Composites Technology (ACT) program. The results of the finite element analyses of the splice joints are presented. The analysis results indicate that failure will not occur in the splice joint regions for loads less than the Design Ultimate Load of the wing box.

Author

Composite Materials; Composite Structures; Compression Loads; Finite Element Method; Graphite-epoxy Composites; Structural Analysis; Wings;

N96-16267*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A unique, optically accessible flame tube combustor for lean combustor studies

Hicks, Yolanda R.; Locke, Randy J.; (NYMA, Inc., Brook Park, OH.)Wey, Chowen C.; (Ohio Aerospace Inst., Cleveland, OH.)and Bianco, Jean; 1 Oct. 1995 11 p Presented at the 31st Joint Propulsion Conference and Exhibit, San Diego, CA, United States, 10-12 Jul. 1995; sponsored by AIAA, ASME, SAE, and ASEE Original contains 1 color illustration

Contract(s)/Grant(s): (NAS3-27186; RTOP 537-02-20)

Report No.(s): (NASA-TM-107073; NAS 1.15:107073; E-9937; AIAA PAPER 95-2685; NIPS-95-06835) Avail: CASI HC A03/MF A01

A facility that allows interrogation of combustions flows by advanced diagnostic methods and instrumentation has been developed at the NASA Lewis Research Center. An optically accessible flame tube combustor is described which has high temperature, pressure, and air flow capabilities. The windows in the combustor measure 3.8 cm axially by 5.1 cm radially, providing 67% optical access to the 7.6 cm x 7.6 cm cross section flow chamber. Advanced gas analysis instrumentation is available through a gas chromatography/mass spectrometer system (GC/MS), which has on-line capability for heavy hydrocarbon measurement with resolution to the parts per billion level. The instrumentation allows one to study combustions flows and combustor subcomponents, such as fuel injectors and air swirlers. Planar Laser Induced Fluorescence (PLIF) can measure unstable combustion species, which cannot be obtained with traditional gas sampling. This type of data is especially useful to combustion modelers. The optical access allows measurements to have high spatial and temporal resolution. GC/MS data and PLIF images of OH- are presented from experiments using a lean direct injection (LDI) combustor burning Jet-A fuel at inlet temperatures ranging from 810 K to 866 K, combustor pressures up to 1380 kPa, and equivalence ratios from 0.41 to 0.59.

Author

Combustible Flow; Combustion Chambers; Flames; Flow Chambers; Fuel Injection; Gas Chromatography; Laser Induced Fluorescence;

N96-16532*# Mississippi State Univ., Mississippi State, MS. Computational Fluid Dynamics Lab.

Nonlinear (time domain) and linearized (time and frequency domain) solutions to the compressible Euler equations in conservation law form Final Report

Sreenivas, Kidambi; and Whitfield, David L.; 21 Aug. 1995 26 p

Contract(s)/Grant(s): (NAG3-767)

Report No.(s): (NASA-CR-199398; NAS 1.26:199398) Avail: CASI HC A03/MF A01

Two linearized solvers (time and frequency domain) based on a high resolution numerical scheme are presented. The basic approach is to linearize the flux vector by expressing it as a sum of a mean and a perturbation. This allows the governing equations to be maintained in conservation law form. A key difference between the time and frequency domain computations is that the frequency domain computations require only one grid block irrespective of the interblade phase angle for which the flow is being computed. As a result of this and due to the fact that the governing equations for this case are steady, frequency domain computations are substantially faster than the corresponding time domain computations. The linearized equations are used to compute flows in turbomachinery blade rows (cascades) arising due to blade vibrations. Numerical solutions are compared to linear theory (where available) and to numerical solutions of the nonlinear Euler equations.

Author

Cascade Flow; Compressible Flow; Computational Fluid Dynamics; Conservation Laws; Euler Equations of Motion; Linearization; Nonlinear Equations; Rotor Aerodynamics; Unsteady Flow;

N96-16573*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

Convective and radiative heating for vehicle return from the Moon and Mars

Greendyke, Robert B.; (Vigyan Research Associates, Inc., Hampton, VA.)and Gnoffo, Peter A.; Jul. 1995 27 p

Contract(s)/Grant(s): (RTOP 242-80-01-01)

Report No.(s): (NASA-TM-110185; NAS 1.15:110185) Avail: CASI HC A03/MF A01

The aerothermal environment is examined for two vehicle forebodies near the peak heating points of lunar and martian return-to-earth trajectories at several nominal entry velocities. The first vehicle forebody is that of a 70 deg aerobrake for entry into earth orbit; the second, a capsule of Apollo configuration for direct entry into the earth's atmosphere. The configurations and trajectories are considered likely candidates for such missions. Two-temperature, thermochemical nonequilibrium models are used in the flow field analyses. In addition to Park's empirical model for dissociation under conditions of thermal nonequilibrium, the Gordiets kinetic model for the homonuclear dissociation of N₂ and O₂ is also considered. Temperature and emission profiles indicate nonequilibrium effects in a 2 to 5 cm post shock region. Substantial portions of the shock layer flow appear to be in equilibrium. The shock layer over an aerobrake for return from the moon exhibits the largest extent of nonequilibrium effects of all considered missions. Differences between the Gordiets and Parks kinetic model were generally very small for the lunar return aerobrake case, the greatest

difference of 6.1 percent occurring in the radiative heating levels.

Author

Aerobraking; Aerodynamic Heating; Convective Heat Transfer; Forebodies; Hypersonic Reentry; Radiative Heat Transfer; Reentry Trajectories; Reentry Vehicles; Return To Earth Space Flight; Space Capsules; Spacecraft Reentry;

N96-16591*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.

Volumetric imaging of supersonic boundary layers using filtered Rayleigh scattering background suppression c34

Forkey, Joseph N.; Lempert, Walter R.; Bogdonoff, Seymour M.; Miles, Richard B.; and Russell, G.; (IBM Watson Research Center, Yorktown Heights, NY.) In its Development of Filtered Rayleigh Scattering for Accurate Measurement of Gas Velocity 10 Sep. 1995 8 p Presented at the 32d Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994 (For primary document see N96-16589 04-70)

Report No.(s): (AIAA PAPER 94-0491) Avail: CASI HC A02/MF A01; 3 functional color pages

We demonstrate the use of Filtered Rayleigh Scattering and a 3D reconstruction technique to interrogate the highly three dimensional flow field inside of a supersonic inlet model. A 3 inch by 3 inch by 2.5 inch volume is reconstructed yielding 3D visualizations of the crossing shock waves and of the boundary layer. In this paper we discuss the details of the techniques used, and present the reconstructed 3D images.

Author

Flow Distribution; Imaging Techniques; Rayleigh Scattering; Supersonic Boundary Layers; Three Dimensional Flow; Three Dimensional Models;

N96-16593*# Texas Univ., Austin, TX. Center for Aeromechanics Research.

Control and reduction of unsteady pressure loads in separated shock wave turbulent boundary layer interaction Final Report, 9 Jan. 1993 - 1 Jan. 1995

Dolling, David S.; and Barter, John W.; Aug. 1995 44 p

Contract(s)/Grant(s): (NAG1-1471)

Report No.(s): (NASA-CR-199334; NAS 1.26:199334)

Copyright Avail: CASI HC A03/MF A01

The focus was on developing means of controlling and reducing unsteady pressure loads in separated shock wave turbulent boundary layer interactions. Section 1 describes how vortex generators can be used to effectively reduce loads in compression ramp interaction, while Section 2 focuses on the effects of 'boundary-layer separators' on the same interaction. For individual titles, see N96-16594 through N96-16595.

Aerodynamic Loads; Boundary Layer Control; Boundary Layer Separation; Corner Flow; Hypersonic Boundary Layer;

Shock Wave Interaction; Turbulent Boundary Layer; Unsteady Flow; Vortex Generators;

N96-16595*# Texas Univ., Austin, TX.

Reduction of fluctuating pressure loads in shock wave turbulent boundary layer interactions c34

Barter, John W.; and Dolling, David S.; In its Control and Reduction of Unsteady Pressure Loads in Separated Shock Wave Turbulent Boundary Layer Interaction Washington AIAA Aug. 1995 19 p (For primary document see N96-16593 04-34) Avail: CASI HC A03/MF A01

Fluctuating surface pressure measurements have been made to investigate the effectiveness of boundary layer separators (BLS's) in reducing the fluctuating pressure loads produced by separated shock wave turbulent boundary layer interactions. Measurements have been made under unswept and swept compression corner interactions in a Mach 5 flow. BLS's fix the separation location and eliminate the large-amplitude, low-frequency fluctuating pressure loads upstream of the compression corners. The loads on the unswept compression corner face are reduced by as much as 59%. The BLS's also shift the mean pressure distribution on the unswept corner face in the streamwise direction. Results show that the loads on the corner face vary with the BLS height and the distance between the BLS and the compression corner. Suggestions for the optimum placement and the use of the BLS's are also made.

Author

Aerodynamic Loads; Boundary Layer Control; Boundary Layer Separation; Corner Flow; Hypersonic Boundary Layer; Pressure Oscillations; Shock Wave Interaction; Turbulent Boundary Layer; Wall Pressure; Wind Tunnel Tests;

N96-16597*# Texas Instruments, Inc., McKinney, TX.

Ka-band MMIC subarray technology program (Ka-Mist)

Pottinger, W.; Sep. 1995 42 p

Contract(s)/Grant(s): (NAS3-25718; RTOP 235-01-00)

Report No.(s): (NASA-CR-195341; E-8912; NAS 1.26:195341) Avail: CASI HC A03/MF A01

Ka-band monolithic microwave integrated circuit (MMIC) arrays have been considered as having high potential for increasing the capability of space, aircraft, and land mobile communication systems in terms of scan performance, data rate, link margin, and flexibility while offering a significant reduction in size, weight, and power consumption. Insertion of MMIC technology into antenna systems, particularly at millimeter wave frequencies using low power and low noise amplifiers in close proximity to the radiating elements, offers a significant improvement in the array transmit efficiency, receive system noise figure, and overall array reliability. Application of active array technology also leads to the use of advanced beamforming techniques that can improve beam agility, diversity, and adaptivity to complex sig-

nal environments. The objective of this program was to demonstrate the technical feasibility of the 'tile' array packaging architecture at EHF via the insertion of 1990 MMIC technology into a functional tile array or subarray module. The means test of this objective was to demonstrate and deliver to NASA a minimum of two 4 x 4 (16 radiating element) subarray modules operating in a transmit mode at 29.6 GHz. Available (1990) MMIC technology was chosen to focus the program effort on the novel interconnect schemes and packaging requirements rather than focusing on MMIC development. Major technical achievements of this program include the successful integration of two 4 x 4 subarray modules into a single antenna array. This 32 element array demonstrates a transmit EIRP of over 300 watts yielding an effective directive power gain in excess of 55 dB at 29.63 GHz. The array has been actively used as the transmit link in airborne/terrestrial mobile communication experiments accomplished via the ACTS satellite launched in August 1993.

Author

Antenna Arrays; Antenna Design; Electronic Modules; Electronic Packaging; Extremely High Frequencies; Integrated Circuits; Microwave Circuits; Mobile Communication Systems;

N96-16615*# Precision Measurement Co., Ann Arbor, MI. Touchdown dynamics c39

Clark, Samuel K.; In NASA. Langley Research Center, Computational Modeling of Tires Aug. 1995 p 9-19 (For primary document see N96-16614 04-39)

Contract(s)/Grant(s): (F33657-92-C-2167) Avail: CASI HC A03/MF A02

Aircraft tire wear results from operating conditions that are quite different from those encountered in land vehicles. One of the most important of these is touchdown, where the tire suddenly spins up from zero to a large angular velocity. This phenomenon is studied from both the analytical and experimental points of view. The analysis is basic, using elementary properties of the tire and wheel. It results in a new dimensionless description of the process. The experimental study consists primarily of small scale laboratory data, although limited full scale tire data is also presented. The data show increasing weight loss during touchdown as the dimensionless severity increases.

Derived from text

Abrasion; Aircraft Landing; Aircraft Tires; Dynamic Structural Analysis; Landing Loads; Sliding Friction; Touchdown; Wear;

N96-16767# California Univ., Irvine, CA. Dept. of Mechanical and Aerospace Engineering.

Droplet-turbulence interactions over a wide spectral range Progress Report, 1 Nov. 1994 - 31 Aug. 1995

Sirignano, William A.; Elghobashi, Said E.; Kim, Inhul; and Masoudi, M.; 1 Sep. 1995 56 p

Contract(s)/Grant(s): (F49620-93-1-0028; AF PROJ. 2308) Report No.(s): (AD-A299578; AFOSR-95-0584TR) Avail: CASI HC A04/MF A01

In the last year, the unsteady, three-dimensional, incompressible, viscous flow interactions between a pair of vortex tubes advected by a uniform free stream and a spherical particle held fixed in space was investigated numerically for a range of particle Reynolds numbers between 20 and 100. Useful correlations of lift coefficient, moment coefficient, and drag coefficient with velocity fluctuation, Reynolds number, offset distance, and initial vortex size have been obtained and reported. A new mechanism based upon droplet lift has been suggested for the dispersion of sprays. Interactions with an array of vortices have resulted in predictive capabilities useful for the study of droplet dispersion in a spray. The case of large vortex-to-droplet diameter has been studied showing that droplet deflection increases with vortex size. The investigation for the heat and mass transfer of a droplet interacting with vortex tubes showed significant sensitivity to the configuration of the interaction. Nusselt numbers were modified from their axisymmetric values.

DTIC

Axisymmetric Flow; Drops (liquids); Flow Characteristics; Free Flow; Incompressible Flow; Particle Interactions; Shear Flow; Spectrum Analysis; Spraying; Three Dimensional Flow; Turbulence Effects; Turbulent Flow; Unsteady Flow; Viscous Flow; Vortices;

N96-16777# Foreign Broadcast Information Service, Washington, DC.

FBIS report: Science and technology. Central Eurasia

21 Aug. 1995 77 p Transl. into ENGLISH from various Central Eurasian articles

Report No.(s): (FBIS-UST-95-033) Avail: CASI HC A05/MF A01

Translated articles cover the following topics: structural state of interfaces in self-reinforced aluminum nitride; multilayer sheet material based on titanium and its alloys; properties of thick plates, rolled from large-capacity sheet ingot; electrohydropulse machining of titanium alloys upon vacuum-arc remelting; interaction of leading shock wave at conical body with low-density region of atmosphere; discharge space in high-current magnetoplasmadynamic motor; effective method of calculating wave impedance of bodies of revolution in transonic-speed range; experimental study of high-frequency secondary perturbations in boundary layer at sweptback wing; strength and toughness of metals over wide range of deformation rates; and dynamic strength of shells made of oriented fibrous composite materials.

Author

Aluminum Nitrides; Conical Bodies; Deformation; Fiber Composites; Machining; Metal Sheets; Sweptback Wings; Thick Plates; Titanium Alloys; Transonic Speed;

N96-16794# Arnold Engineering Development Center, Arnold AFS, TN.

NEDANA: A three-dimensional, thermochemical nonequilibrium, chimera-based flow solver Final Report, Oct. 1990 - Sep. 1994

Rock, S. G.; Tramel, R. W.; and Keeling, S. L.; Jul. 1995 134 p

Report No.(s): (AD-A297032; AEDC-TR-94-18) Avail: CASI HC A07/MF A02

A new three-dimensional nonequilibrium diagonal approximate Newton's algorithm (NEDANA) has been developed for flows with thermal and chemical nonequilibrium. Changing chemistry and thermal models is straightforward because the flow solver receives chemical, thermodynamic, and transport properties from the NEQPAK library of subroutines. The flow solver is developed in the chimera domain decomposition architecture in order to incorporate complex multiple-body configurations and moving grids. Excellent agreement was obtained in comparisons of the new flow solver with steady-state experimental data and solutions from existing state-of-the-art flow solvers.

DTIC

Aerothermodynamics; Compressible Flow; Computational Fluid Dynamics; Computational Grids; Computer Programs; Nonequilibrium Flow; Supersonic Flow; Three Dimensional Flow;

N96-16812# Naval Research Lab., Washington, DC.

The relative effects of CW and RP lasers on composites and metals Interim Report

Mueller, George P.; 7 Sep. 1995 22 p

Report No.(s): (AD-A299524; NRL/MR/6656-95-7773) Avail: CASI HC A03/MF A01

DoD aircraft structural materials include both metals, primarily aluminum, and composites, primarily graphite/epoxy. The effect of lasers on these two materials is considerably different because of the large differences in some of their thermal properties. There are also significant differences depending on whether the laser irradiation is due to a continuous wave (CW) laser or a repetitively pulsed (RP) laser. Using the one-dimensional thermal response code FLIKER the effects of both CW and Rp irradiations on aluminum and graphite/epoxy were modeled. Two classes of effects were examined: the immediate effects during the irradiations and the post irradiation damage effects.

DTIC

Aircraft Structures; Continuous Wave Lasers; Damage Assessment; Laser Outputs; Metal Matrix Composites; Radiation Damage; Radiation Effects;

N96-17080*# Department of the Air Force, Wright-Patterson AFB, OH.

Life prediction of aging aircraft wiring systems c33

Slenski, George; In NASA. Lewis Research Center, Third

NASA Workshop on Wiring for Space Applications 1 Nov. 1995 p 27-30 (For primary document see N96-17077 04-20) Avail: CASI HC A01/MF A03; 2 functional color pages

The program goal is to develop a computerized life prediction model capable of identifying present aging progress and predicting end of life for aircraft wiring. A summary is given in viewgraph format of progress made on phase 1 objectives, which were to identify critical aircraft wiring problems; relate most common failures identified to the wire mechanism causing the failure; assess wiring requirements, materials, and stress environment for fighter aircraft; and demonstrate the feasibility of a time-temperature-environment model.

CASI

Aircraft Reliability; Circuit Reliability; Electric Wire; Electrical Faults; Performance Prediction; Service Life; System Failures;

N96-17082*# Federal Aviation Administration, Atlantic City, NJ.

Electrical short circuit and current overload tests on aircraft wiring c33

Cahill, Patricia; In NASA. Lewis Research Center, Third NASA Workshop on Wiring for Space Applications 1 Nov. 1995 p 41-48 (For primary document see N96-17077 04-20) Avail: CASI HC A02/MF A03; 2 functional color pages

The findings of electrical short circuit and current overload tests performed on commercial aircraft wiring are presented. A series of bench-scale tests were conducted to evaluate circuit breaker response to overcurrent and to determine if the wire showed any visible signs of thermal degradation due to overcurrent. Three types of wire used in commercial aircraft were evaluated: MIL-W-22759/34 (150 C rated), MIL-W-81381/12 (200 C rated), and BMS 1360 (260 C rated). A second series of tests evaluated circuit breaker response to short circuits and ticking faults. These tests were also meant to determine if the three test wires behaved differently under these conditions and if a short circuit or ticking fault could start a fire. It is concluded that circuit breakers provided reliable overcurrent protection. Circuit breakers may not protect wire from ticking faults but can protect wire from direct shorts. These tests indicated that the appearance of a wire subjected to a current that totally degrades the insulation looks identical to a wire subjected to a fire; however the 'fire exposed' conductor was more brittle than the conductor degraded by overcurrent. Preliminary testing indicates that direct short circuits are not likely to start a fire. Preliminary testing indicated that direct short circuits do not erode insulation and conductor to the extent that ticking faults did. Circuit breakers may not safeguard against the ignition of flammable materials by ticking faults. The flammability of materials near ticking faults is far more important than the rating of the wire insulation material.

Derived from text

Circuit Breakers; Circuit Protection; Commercial Aircraft; Electric Arcs; Electric Wire; Flammability; Short Circuits;

N96-17083*# Naval Air Warfare Center, Indianapolis, IN.
Aircraft wiring program status report c33

Beach, Rex; In NASA. Lewis Research Center, Third NASA Workshop on Wiring for Space Applications 1 Nov. 1995 p 49-54 (For primary document see N96-17077 04-20) Avail: CASI HC A02/MF A03; 2 functional color pages

In this Naval Air Warfare Center (NAWC) Aircraft Division status report, the general and wire and cable component activities, the systems engineering activities, the aircraft wiring lead maintenance activities, the NAVAIR/NASA interface activities, and the Base Realignment and Closure (BRAC) Commission recommendations are presented. CASI

Aerospace Engineering; Aircraft Construction Materials; Aircraft Design; Military Operations; Military Technology; Quality Control; Systems Engineering; Wiring;

N96-17090*# Tensolite Co., Saint Augustine, FL.

An advanced arc track resistant airframe wire c33

Beatty, J.; In NASA. Lewis Research Center, Third NASA Workshop on Wiring for Space Applications 1 Nov. 1995 p 129-141 (For primary document see N96-17077 04-20) Avail: CASI HC A03/MF A03; 2 functional color pages

Tensolite, a custom cable manufacturer specializing in high temperature materials as the dielectric medium, develops an advance arc track resistant airframe wire called Tufflite 2000. Tufflite 2000 has the following advantages over the other traditional wires: lighter weight and smaller in diameter; excellent wet and dry arc track resistance; superior dynamic cut-through performance even at elevated temperatures; flight proven performance on Boeing 737 and 757 airplanes; and true 260 C performance by utilizing Nickel plated copper conductors. This paper reports the different tests performed on Tufflite 2000: accelerated aging, arc resistance (wet and dry), dynamic cut through, humidity resistance, wire-to-wire abrasion, flammability, smoke, weight, notch sensitivity, flexibility, and markability. It particularly focuses on the BSI (British Standards Institute) dry arc resistance test and BSI wet arc tracking.

CASI

Airframes; Electric Arcs; Electric Wire; Environmental Tests; Performance Tests; Refractory Materials;

N96-17136# Defence Science and Technology Organisation, Canberra (Australia).

A review of Australian and New Zealand investigations on aeronautical fatigue during the period April 1993 to March 1995

Grandage, J. M.; and Jost, G. S.; Mar. 1995 34 p
Report No.(s): (AD-A299447; DSTO-TN-0002; DODA-AR-009-202) Avail: CASI HC A03/MF A01

This document was prepared for presentation to the 24th Conference of the International Committee on Aeronautical Fatigue scheduled to be held in Melbourne, Australia on May 1 and 2, 1995. A review is given of the aircraft fatigue research and associated activities which form part of the programs of the Aeronautical and Maritime Research Laboratory, Universities, the Civil Aviation Authority and the Defense Scientific Establishment, New Zealand. The review summarizes fatigue-related research programs as well as fatigue investigations on specific military and civil aircraft.

DTIC

Aeronautical Engineering; Aircraft Structures; Fatigue (materials); Research Projects;

N96-17211# California Inst. of Tech., Pasadena, CA. Dept. of Electrical Engineering.

Microsensors for turbulent flow diagnostics Final Technical Report, 15 Jul. 1992 - 14 Apr. 1995

Tai, Yu-Chong; 31 Jul. 1995 11 p

Contract(s)/Grant(s): (F49620-92-J-0424)

Report No.(s): (AD-A299481; AFOSR-95-0644TR) Avail: CASI HC A03/MF A01

There are two tasks in this grant. The first is to develop a micromachined miniature polysilicon hot-wire anemometers with improved spatial resolution and frequency response. The finished device was a micron sized polysilicon wire supported by free-standing gold/silicon-nitride beams. These devices have time constants as small as a few microseconds and, under constant temperature mode, an unprecedented bandwidth of 1.4 N 4Hz was achieved measured in wind tunnel. The second task is to study gaseous microchannel flows as an effort to understand the basic science of fluid mechanics when the mean free path of the gas is about the size of the channel. A micromachined microsystem was developed with a micron-sized flow channel (one micron high) and (4 or 13) distributed pressure sensors. A range of pressure drop up to 20 psi was used and nonlinear pressure distributions were for the first time, successfully obtained. It was found that surface-gas interaction plays an important role in the flow behavior in microflow systems and that new flow models have to be developed to explain the new phenomena.

DTIC

Diagnosis; Fluid Mechanics; Frequency Response; Hot-wire Anemometers; Mean Free Path; Micromachining; Miniaturization; Silicon Polymers; Spatial Distribution; Spatial Resolution; Time Constant; Turbulent Flow; Wind Tunnels;

N96-17393# Colorado Univ., Boulder, CO. Dept. of Physics.
Tunable antennas using thin film ferroelectrics Letter Report, 1 Oct. 1993 - 30 Sep. 1994

Price, John C.; 30 Sep. 1994 7 p

Contract(s)/Grant(s): (N00014-93-1-0592)

Report No.(s): (AD-A299576) Avail: CASI HC A02/MF A01

There are military needs greatly improve airborne detection of sources of electromagnetic radiation in the VHF and UHF bands. Many of the applications could be met using electrically small antenna elements in a superdirective array, provided the losses in the antenna structure can be made small enough and bandwidth limitations are overcome with dynamically tunable matching networks. We are seeking to demonstrate a solution to these problems by combining thin film ferroelectric capacitors (to create electrically tunable matching networks) with high temperature superconductors (to create a low loss antenna structures). We will fabricate and test a half-loop antenna designed to meet a specific military application: mid-course guidance for missiles. The result of this program will allow evaluation of this technology for use in a broad range guidance and avionics applications. In parallel with the antenna fabrication we will develop ferroelectric thin films with highly tunable dielectric constants and low loss tangents, at low temperature (77K) and high frequency (500 MHz and above).

Derived from text

Aerial Reconnaissance; Antenna Components; Antenna Design; Capacitors; Electromagnetic Radiation; Fabrication; Ferroelectricity; High Temperature Superconductors; Thin Films;

N96-17424# Wright Lab., Wright-Patterson AFB, OH. Aeropropulsion and Power Directorate.

Digital rotational speed measurement Final Report, 1 Aug. 1993 - 1 May 1995

Fischer, Ronald J.; May 1995 50 p Limited Reproducibility: Document partially illegible

Contract(s)/Grant(s): (AF PROJ. 3066)

Report No.(s): (AD-A299776; WL-TR-95-2056) Avail: CASI HC A03/MF A01

The compressor research facility (CRE) located at Wright Patterson AFB, Ohio is configured to Permi. The evaluation of full-scale fans or compressors in simulated flight conditions. Rotational speed measurement is used both for control and performance data collection of compressors under test. This report describes the design of an integrated circuit and supporting hardware for replacing the older rotational measurement system currently in use in the CRF.

DTIC

Compressors; Digital Systems; Integrated Circuits; Logic Circuits; Rotation; Velocity Measurement;

13 GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

N96-17202# Clarkson Univ., Potsdam, NY. Dept. of Chemical Engineering.

A system for aerodynamically sizing ultrafine environmental radioactive particles

Olawoyin, L.; Sep. 1995 104 p

Contract(s)/Grant(s): (DE-FG02-90ER-61029)

Report No.(s): (DE95-017100; DOE/ER-61029/19) Avail: CASI HC A06/MF A02

The unattached environmental radioactive particles/clusters, produced mainly by Rn-222 in indoor air, are usually few nanometers in size. The inhalation of these radioactive clusters can lead to deposition of radioactivity on the mucosal surface of the tracheobronchial tree. The ultimate size of the cluster together with the flow characteristics will determine the depositional site in the human lung and thus, the extent of damage that can be caused. Thus, there exists the need for the determination of the size of the radioactive clusters. However, the existing particle measuring device have low resolution in the sub-nanometer range. In this research, a system for the alternative detection and measurement of the size of particles/cluster in the less than 2 nm range have been developed. The system is a one stage impactor which has a solid state spectrometer as its impaction plate. It's major feature is the nozzle-to-plate separation, L. The particle size collected changes with L and thus, particle size spectroscopy is achieved by varying L. The number of collected particles is determined by alpha spectroscopy. The size-discriminating ability of the system was tested with laboratory generated radon particles and it was subsequently used to characterize the physical (size) changes associated with the interaction of radon progeny with water vapor and short chain alcohols in various support gases. The theory of both traditional and high velocity jet impactors together with the design and evaluation of the system developed in this study are discussed in various chapters of this dissertation. The major results obtained in the course of the study are also presented.

DOE

Design Analysis; Flow Characteristics; Gas Flow; Impactors; Lungs; Mathematical Models; Particle Size Distribution; Performance Tests; Radioactive Contaminants; Radon Isotopes; Respiration;

N96-17343 Massachusetts Inst. of Tech., Cambridge, MA. **Assimilation of altimeter data in a quasi-geostrophic model of the Gulf Stream system: A dynamical perspective Ph.D. Thesis**

Capotondi, Antonietta; 1 Jan. 1993

Report No.(s): (NIPS-96-07413) Avail: Issuing Activity (MIT Libraries, Rm. 14-0551, Cambridge, MA 02139-4307)

The dynamical aspects involved in the assimilation of altimeter data in a numerical ocean model have been investigated. The model used for this study is a quasi-geostrophic model of the Gulf Stream region. The data that have been as-

simulated are maps of sea surface height which have been obtained as the superposition of sea surface height variability deduced from the Geosat altimeter measurements and a mean field constructed from historical hydrographic data. The method used for assimilating the data is the nudging technique. Nudging has been implemented in such a way as to achieve a high degree of convergence of the surface model fields toward the observations. We have analyzed the mechanisms of the model adjustment, and the final statistical equilibrium characteristics of the model simulation when the surface data are assimilated. Since the surface data are the superposition of a mean component and an eddy component, in order to understand the relative role of these two components in determining the characteristics of the final statistical steady state, we have considered two different experiments: in the first experiment only the climatological mean field is assimilated, while in the second experiment the total surface streamfunction field (mean + eddies) has been used. We have found that the mean component of the surface data determines, to a large extent, the structure of the flow field in the subsurface layers, while the eddy field, as well as the inflow/outflow conditions at the open boundaries, affect its intensity. In particular, if surface eddies are not assimilated only a weak flow develops in the two deeper model layers where no inflow/outflow is prescribed at the boundaries. Comparisons of the assimilation results with available in situ observations show a considerable improvement in the degree of realism of the climatological model behavior, with respect to the model in which no data are assimilated. In particular, the possibility of building into the model more realistic eddy characteristics, through the assimilation of the surface eddy field, proves very successful in driving components of the mean model circulation that are in good agreement with the available observations.

Dissert. Abstr.

Assimilation; Data Correlation; Gulf Stream; Hydrography; Ocean Models;

14 LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and planetary biology.

No abstracts in this category.

15 MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and

software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

N96-16247# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

Special Course on Parallel Computing in CFD [L'Aérodynamique numérique et le calcul en parallèle]

1 Oct. 1995 346 p Presented at the AGARD-FDP-VKI Special Course, Rhode-Saint-Genese, Belgium, 15-19 May 1995, and at the AGARD-FDP-VKI Special Course, Moffett field, CA, United States, 16-20 Oct. 1995; sponsored by Von Karman Inst. for Fluid Dynamics Prepared in cooperation with Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium)

Report No.(s): (AGARD-R-807; ISBN-92-836-1025-3; NIPS-95-06204) Avail: CASI HC A15/MF A03

Lecture notes for the AGARD Fluid Dynamics Panel (FDP) Special Course on 'Parallel Computing in CFD' have been assembled in this report. The aim and scope of this Course was to present and discuss the latest advances and future trends in the application of parallel computing to solve computationally intensive problems in computational fluid dynamics (CFD). Topics in this lecture series focus on the increasingly sophisticated types of architectures now available, and how to exploit these architectures by appropriate algorithms for the simulation of fluid flow. Some of the subjects discussed are: parallel algorithms for computing compressible and incompressible flow; domain decomposition algorithms and partitioning techniques; and parallel algorithms for solving linear systems arising from the discretized partial differential equations. For individual titles, see N96-16248 through N96-16255.

Algorithms; Computational Fluid Dynamics; Parallel Processing (computers);

N96-16251# Deutsche Forschungsanstalt fuer Luft- und Raumfa, Brunswick (Germany). Inst. for Design Aerodynamics.

Structured grid solvers 1: Accurate and efficient flow solvers for 3D applications on structured meshes c62

Kroll, Norbert; Radespiel, Rolf; and Rossow, Cord-C.; In AGARD, Special Course on Parallel Computing in CFD 1 Oct. 1995 59 p (For primary document see N96-16247 04-60) Avail: CASI HC A04/MF A03

This lecture is devoted to the parallelization of block structured grid solvers for industrial applications. It is divided into two parts. Part 1 describes well established numerical algorithms with emphasis on spatial discretization and time stepping schemes. Attention is focused on the multigrid technique which is one of the most promising approaches to improve the efficiency of numerical methods. Finally, several large-scale computations are shown which demonstrate the ability of current block structured flow solvers. Part 2 of

the lecture addresses various aspects of the parallelization of such flow solvers.

Author

Algorithms; Computational Fluid Dynamics; Finite Volume Method; Navier-stokes Equation; Structured Grids (mathematics); Three Dimensional Flow;

N96-16253*# Rensselaer Polytechnic Inst., Troy, NY. Scientific Computation Research Center.

Parallel automated adaptive procedures for unstructured meshes c62

Shephard, M. S.; Flaherty, J. E.; Decougnny, H. L.; Ozturan, C.; Bottasso, C. L.; and Beall, M. W.; In AGARD, Special Course on Parallel Computing in CFD 1 Oct. 1995 49 p (For primary document see N96-16247 04-60)

Contract(s)/Grant(s): (NAG2-832) Avail: CASI HC A03/MF A03

Consideration is given to the techniques required to support adaptive analysis of automatically generated unstructured meshes on distributed memory MIMD parallel computers. The key areas of new development are focused on the support of effective parallel computations when the structure of the numerical discretization, the mesh, is evolving, and in fact constructed, during the computation. All the procedures presented operate in parallel on already distributed mesh information. Starting from a mesh definition in terms of a topological hierarchy, techniques to support the distribution, redistribution and communication among the mesh entities over the processors is given, and algorithms to dynamically balance processor workload based on the migration of mesh entities are given. A procedure to automatically generate meshes in parallel, starting from CAD geometric models, is given. Parallel procedures to enrich the mesh through local mesh modifications are also given. Finally, the combination of these techniques to produce a parallel automated finite element analysis procedure for rotorcraft aerodynamics calculations is discussed and demonstrated.

Author

Algorithms; Computational Fluid Dynamics; Grid Generation (mathematics); Parallel Processing (computers); Unstructured Grids (mathematics);

N96-16255*# Colorado Univ., Boulder, CO. Dept. of Aerospace Engineering Sciences.

High performance simulation of coupled nonlinear transient aeroelastic problems c62

Farhat, Charbel; In AGARD, Special Course on Parallel Computing in CFD 1 Oct. 1995 79 p Prepared in cooperation with NASA. Langley Research Center, Hampton, VA (For primary document see N96-16247 04-60)

Contract(s)/Grant(s): (NAG2-827; NAG1-5364; NSF ASC-92-17394) Avail: CASI HC A05/MF A03

The accurate prediction of aeroelastic phenomena such as divergence and flutter is essential in the design of high per-

formance and safe aircraft. This prediction requires solving simultaneously the coupled fluid and structural equations of motion. Therefore numerical aeroelastic simulations are, in general, resource intensive. They belong to the family of Grand Challenge engineering problems and as such, can benefit from parallel processing technology. This paper highlights some important aspects of nonlinear computational aeroelasticity. These include a three-field arbitrary Lagrangian-Eulerian (ALE) finite element/volume formulation for coupled transient aeroelastic problems; a rigorous derivation of geometric conservation laws (GCLs) for flow problems with moving boundaries and unstructured deformable meshes; the design of a family of staggered procedures for the efficient solution of the coupled fluid/structure partial differential equations; and fast parallel domain decomposition solvers. The derivations of the GCLs are presented for ALE based finite volume formulations as well as ALE based stabilized finite element methods. The impact of these GCLs on the numerical algorithms used for time-integrating the semi-discrete equations governing the structural and fluid mesh motions is also discussed. The solution of the governing three-field equations with mixed implicit/implicit and explicit/implicit staggered procedures are analyzed with particular reference to accuracy, stability, subcycling, distributed computing, I/O transfers, and parallel processing. A general and flexible framework for implementing the partitioned analysis of coupled transient aeroelastic problems with non-matching fluid/structure interfaces on heterogeneous and/or parallel computational platforms is also described. This framework and the staggered solution procedures are demonstrated with examples ranging from the numerical investigation on an iPSC-860 massively parallel processor of the instability of flat panels with infinite aspect ratio in supersonic airstreams, to the solution on the Paragon XP/S, Cray T3D and IBM SP2 parallel systems of three-dimensional wing response problems in the transonic regime.

Author (revised)

Aeroelasticity; Algorithms; Computational Fluid Dynamics; Nonlinear Systems; Parallel Processing (computers);

N96-16383*# Honeywell Technology Center, Minneapolis, MN.

Panoramic, large-screen, 3-D flight display system design Final Report, 8 Nov. 1993 - 4 Aug. 1995

Franklin, Henry; (Honeywell Technology Center, Phoenix, AZ.)Larson, Brent; (Honeywell Technology Center, Phoenix, AZ.)Johnson, Michael; (Honeywell Technology Center, Phoenix, AZ.)Droessler, Justin; and Reinhart, William F.; 1 Oct. 1995 312 p

Contract(s)/Grant(s): (NAS1-20073; RTOP 537-08-20-01) Report No.(s): (NASA-CR-198218; NAS 1.26:198218; NIPS-95-06376) Avail: CASI HC A14/MF A03

The report documents and summarizes the results of the required evaluations specified in the SOW and the design specifications for the selected display system hardware. Also included are the proposed development plan and schedule as well as the estimated rough order of magnitude (ROM) cost to design, fabricate, and demonstrate a flyable prototype research flight display system. The thrust of the effort was development of a complete understanding of the user/system requirements for a panoramic, collimated, 3-D flyable avionic display system and the translation of the requirements into an acceptable system design for fabrication and demonstration of a prototype display in the early 1997 time frame. Eleven display system design concepts were presented to NASA LaRC during the program, one of which was down-selected to a preferred display system concept. A set of preliminary display requirements was formulated. The state of the art in image source technology, 3-D methods, collimation methods, and interaction methods for a panoramic, 3-D flight display system were reviewed in depth and evaluated. Display technology improvements and risk reductions associated with maturity of the technologies for the preferred display system design concept were identified.

Author

Display Devices; Flight Instruments; Projectors; Stereoscopic Vision; Technology Assessment; User Requirements;

N96-16636*# Institute for Computer Applications in Science and Engineering, Hampton, VA.

Pseudo-time method for optimal shape design using the Euler equations Final Report

Iollo, Angelo; Kuruwila, Geojoe; and Ta'asan, Shlomo; Aug. 1995 24 p Submitted for publication in AIAA Journal Contract(s)/Grant(s): (NAS1-19480; RTOP 505-90-52-01) Report No.(s): (NASA-CR-198205; NAS 1.26:198205; ICASE-95-59) Avail: CASI HC A03/MF A01

We exploit a novel idea for the optimization of flows governed by the Euler equations. The algorithm consists of marching on the design hypersurface while improving the distance to the state and costate hypersurfaces. We consider the problem of matching the pressure distribution to a desired one, subject to the Euler equations, both for subsonic and supersonic flows. The rate of convergence to the minimum for the cases considered is 3 to 4 times slower than that of the analysis problem. Results are given for Ringleb flow and a shockless recompression case.

Author

Aerodynamic Configurations; Algorithms; Compressible Flow; Computational Fluid Dynamics; Computer Aided Design; Euler Equations of Motion; Iterative Solution; Optimization; Time Dependence; Two Dimensional Models;

N96-16913*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.

Control theory based airfoil design for potential flow and a finite volume discretization

Reuther, J.; and Jameson, A.; 1 Jan. 1994 14 p

Contract(s)/Grant(s): (NCC2-5012)

Report No.(s): (NASA-CR-199969; NAS 1.26:199969; NIPS-96-07048) Avail: CASI HC A03/MF A01

This paper describes the implementation of optimization techniques based on control theory for airfoil design. In previous studies it was shown that control theory could be used to devise an effective optimization procedure for two-dimensional profiles in which the shape is determined by a conformal transformation from a unit circle, and the control is the mapping function. The goal of our present work is to develop a method which does not depend on conformal mapping, so that it can be extended to treat three-dimensional problems. Therefore, we have developed a method which can address arbitrary geometric shapes through the use of a finite volume method to discretize the potential flow equation. Here the control law serves to provide computationally inexpensive gradient information to a standard numerical optimization method. Results are presented, where both target speed distributions and minimum drag are used as objective functions.

Author

Airfoil Profiles; Airfoils; Control Theory; Design Analysis; Finite Volume Method; Optimization; Potential Flow; Three Dimensional Models;

N96-16942*# Tennessee Univ. - Calspan, Tullahoma, TN. Center for Space Transportation and Applied Research.

Neural networks analysis on SSME vibration simulation data c63

Lo, Ching F.; and Wu, Kewei; In its Center for Space Transportation and Applied Research Fifth Annual Technical Symposium Proceedings 1 Jan. 1993 00016 p (For primary document see N96-16940 04-20) Avail: CASI HC A03/MF A02

The neural networks method is applied to investigate the feasibility in detecting anomalies in turbopump vibration of SSME to supplement the statistical method utilized in the prototype system. The investigation of neural networks analysis is conducted using SSME vibration data from a NASA developed numerical simulator. The limited application of neural networks to the HPFTP has also shown the effectiveness in diagnosing the anomalies of turbopump vibrations.

Author

Anomalies; Applications Programs (computers); Artificial Intelligence; Change Detection; Expert Systems; Network Analysis; Neural Nets; Software Engineering; Structural Vibration; Turbine Pumps;

16 PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

N96-16273*# Boeing Defense and Space Group, Philadelphia, PA. Helicopters Div.

Evaluation of the impact of noise metrics on tiltrotor aircraft design Final Report

Sternfeld, H.; Spencer, R.; and Ziegenbein, P.; 1 Nov. 1995 38 p

Contract(s)/Grant(s): (NAS1-20095; RTOP 538-07-15-10)

Report No.(s): (NASA-CR-198240; NAS 1.26:198240; NIPS-95-06842) Avail: CASI HC A03/MF A01

A subjective noise evaluation was conducted in which the test participants evaluated the annoyance of simulated sounds representative of future civil tiltrotor aircraft. The subjective responses were correlated with the noise metrics of A-weighted sound pressure level, overall sound pressure level, and perceived level. The results indicated that correlation between subjective response and A-weighted sound pressure level is considerably enhanced by combining it in a multiple regression with overall sound pressure level. As a single metric, perceived level correlated better than A-weighted sound pressure level due to greater emphasis on low frequency noise components. This latter finding was especially true for indoor noise where the mid and high frequency noise components are attenuated by typical building structure. Using the results of the subjective noise evaluation, the impact on tiltrotor aircraft design was also evaluated. While A-weighted sound pressure level can be reduced by reduction in tip speed, an increase in number of rotor blades is required to achieve significant reduction of low frequency noise as measured by overall sound pressure level. Additional research, however, is required to achieve comparable reductions in impulsive noise due to blade-vortex interaction, and also to achieve reduction in broad band noise.

Author

Aircraft Design; Noise Intensity; Psychoacoustics; Sound Pressure; Tilt Rotor Aircraft;

N96-16911 Foreign Broadcast Information Service, Washington, DC.

FBIS report: Science and technology. Central Eurasia

30 Nov. 1995 89 p

Report No.(s): (FBIS-UST-95-048; NIPS-96-06857) Copyright Avail: Issuing Activity (Foreign Broadcast Information Service, Washington, DC)

Translated articles cover the following topics: flame bench tests to determine whether a solid-fuel-fired rocket en-

gine can withstand a short-term lateral load; Russian sole optical reconnaissance satellite; Russian design for vectored thrust uses turboprop engine; Russian aircraft optronics detailed at Moscow Air Show; photoreconnaissance satellites deliver high quality at low cost; lunar flyby; commercial use of satellite technology described; the nature of ball lightning; dynamic compacting of hydrated titanium powder; and combined mode locking of solid-state lasers with self-focusing in synchronous pumping.

CASI

Aerospace Engineering; Chemistry; Commonwealth of Independent States; Physics; Policies; Research and Development; Russian Federation; Technologies;

N96-17205# Army Research Lab., Aberdeen Proving Ground, MD.

A method of identifying supersonic projectiles using acoustic signatures Report, Apr. 1992 - Aug. 1993

Loucks, Richard B.; Davis, Bradford S.; Moss, Linda; Pham, Tien; and Fong, Manfai; Sep. 1995 223 p

Contract(s)/Grant(s): (DA PROJ. 1L1-62618-AH-80)

Report No.(s): (AD-A299462; ARL-TR-859) Avail: CASI HC A10/MF A03

There was a need to investigate the feasibility of attaching a device to the existing Remote Equipment Target System (RETS) such that RETS would be able to identify the type of projectile that struck the target. A concept was developed to identify projectiles acoustically by measuring some characteristics of N-Wave produced from the projectile's sonic boom. High-fidelity microphones were positioned to provide N-Wave profiles. The distance between the sonic boom's source and the microphone was the most important parameter. An array of six low-fidelity microphones was used to locate the projectile location. By utilizing the sonic boom arrival times and knowledge of the spatial locations of the low-fidelity microphones, the location of the projectile relative to the high-fidelity microphones was determined. The concept development was broken into three phases-feasibility, data collection, and finally validation and verification of the concept's functionality. A prototype unit called a Round Discrimination System (RDS) was fabricated and field tested in the validation/verification phase. The RDS unit was transported to the 7th ATC in Germany for a demonstration. This report provides details of each phase of the development program and the results of the on-site demo in Germany.

DTIC

Acoustic Properties; Air Traffic Control; Data Acquisition; Identifying; Projectiles; Remote Control; Sonic Booms; Spatial Distribution; Targets;

17 SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

No abstracts in this category.

18 SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

No abstracts in this category.

19 GENERAL

No abstracts in this category.

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